PB85-134153

Dicofol: Special Review
Position Document 2/3

(U.S.) Environmental Protection Agency
Washington, DC

Oct 84

U.S. Department of Commerce
National Technical Information Service
NTIS

United States
Environmental Protection
Agency

Office of
Pesticides and Toxic Substances
Washington, DC 20460

October 1984

PB85-134153

Pesticides

EPA

Dicofol

Special Review Position Document 2/3

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

50272-101

REPORT DOCUMENTATION PAGE	**1. REPORT NO.**	**2.**	**3. Recipient's Accession No.** PB85 134153

4. Title and Subtitle

DICOFOL SPECIAL REVIEW POSITION DOCUMENT 2/3

5. Report Date

Issued: October 1984

6.

7. Author(s)

EPA, OPP, Registration Division

8. Performing Organization Rept. No.

540/9-84-004

9. Performing Organization Name and Address

Environmental Protection Agency
Office of Pesticide Programs (TS-766)
Washington, D.C. 20460

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.

(C)

(G)

12. Sponsoring Organization Name and Address

SAME AS #9

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

This Position Document 2/3 (PD 2/3) describes regulatory actions to reduce the potential adverse environmental effects from registered uses of Dicofol. The proposed action is based on the Agency's determination that uses of Dicofol contaminated with DDT and related compounds (collectively referred to as DDTr) will result in unreasonable adverse effects to nontarget wildlife, especially endangered species. The Guidance Document, issued by the Agency in December, 1983, described the Agency's concerns in detail and also set forth data and labeling requirements for continued registration of Dicofol. A Special Review was initiated by the Agency on March 21, 1984 (49 FR 10569) and invited comments from the registrants as well as from the public. The comments received during the 45-day comment period were from the registrants, environmental groups, and agricultural cooperative agents. All of the comments were reviewed for pertinent information. The Agency's determination of unreasonable adverse effects is based on weighing the risks and benefits of Dicofol use. The Agency's analysis of the benefits of Dicofol use indicated that, although economic impacts would result from cancellation, these impacts did not outweigh the risks. An analysis of the benefits associated with each use reveals that alternative pesticides are available. The Agency proposes to cancel all registrations for Dicofol because the risks of continued use outweigh the benefits. A 30-day comment period, beginning on the date of the issuance

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement freely available	**19. Security Class (This Report)** unclassified	**21. No. of Pages** 146
	20. Security Class (This Page)	**22. Price**

(See ANSI–Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4–77)
(Formerly NTIS–35)
Department of Commerce

17

16. Abstract Cont'd

of the Federal Register notice, will allow the Scientific Advisory Panel and the Secretary of Agriculture to review and comment on the Agency's proposed decision, and a 45-day comment period will be given to the registrants, and the public for review and comment. After analyzing these comments the Agency will issue a PD 4 containing the Agency's final decision.

DICOFOL POSITION DOCUMENT 2/3

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540/9-84-004 10/84

B

EXECUTIVE SUMMARY

This Position Document 2/3 (PD 2/3) describes regulatory actions to reduce the potential adverse environmental effects from registered uses of dicofol. The proposed action is based on the Agency's determination that uses of dicofol contaminated with DDT and related compounds (collectively referred to as DDTr) will result in unreasonable adverse effects to non-target wildlife, especially endangered species. The "Guidance Document for the Reregistration of Pesticide Products Containing Dicofol as an Active Ingredient," issued by the Agency in December, 1983, described the Agency's concerns in detail and also set forth data and labeling requirements for continued registration of dicofol. A Special Review was initiated by the Agency on March 21, 1984, (49 FR 10569) and invited comments from the registrants as well as from the public. The comments received during the 45-day comment period were from the registrants, environmental groups, and agricultural cooperative agents. All of the comments were reviewed for pertinent information.

The Agency's determination of unreasonable adverse effects is based on weighing the risks and benefits of dicofol use. The risk assessment is based in part on models used to determine the environmental transport and accumulation of these contaminants in the citrus growing areas of the Arroyo Colorado river basin and cotton growing areas of Kings County, California. These models indicated the potential for the DDTr contaminants to accumulate to levels which cause adverse effects to fish and birds. The determination is also based on the fact that there are areas of the country in which dicofol usage is high and monitoring data show that DDTr residues are also high in the water and wildlife inhabiting those areas. The Agency has determined that the evidence clearly indicates that the use of dicofol in these areas makes a significant contribution to the ambient levels of DDTr.

The Agency is also concerned about the potential oncogenicity of the DDTr impurities as well as dicofol itself thus, The Agency is currently reassessing the weight of evidence to develop appropriate measures of oncogenic potency for the chemicals so that it can be incorporated into the Agency's risk assessment. This new assessment should be included in the Position Document 4 (PD 4).

The annual usage level ranges from 2.0 to 2.5 million pounds of dicofol active ingredient. The major pesticidal uses are the applications to citrus and cotton to control various species of mites. Approximately two-thirds of the dicofol used in the U.S. is used on these two sites. The remainder is used on seed crops, stone and pome fruits, figs, vegetables, small fruits, tree nuts, mint, ornamental plants, turf grasses, greenhouse crops, house plants, plus sites in and around domestic dwellings and commercial and agricultural buildings.

The Agency's analysis of the benefits of dicofol use indicated that, although economic impacts would result from cancellation, these impacts did not outweigh the risks. An analysis of the benefits associated with each use reveals that alternative pesticides are available. Economic impacts resulting from the cancellation of dicofol will be felt primarily by cotton producers in the San Joaquin Valley of California, due mainly to yield reductions. However, these impacts are not significant at a national level. Economic impacts to citrus growers from dicofol cancellation would be due to the use of costlier alternatives. Additional costs would be realized if there were yield and quality declines associated with the use of these alternatives. The economic impacts relating use of dicofol on all minor crops has not been quantified. Some of these sites may realize negative economic impacts, the magnitude of which is unknown at this time. However, alternatives are available for most minor uses so the impacts should not be significant.

Various options were considered by the Agency to reduce the potential environmental risks due to the use of dicofol. One option was to reduce the DDTr levels in dicofol. Lowering the DDTr contamination in dicofol to the levels suggested by the registrants would not be adequate to mitigate the risks because significant adverse effects are still anticipated to occur. Another option was to place various restrictions on dicofol use, i.e., to restrict the use to certain geographic areas or to reduce the application amounts. The Agency also concluded that this option would not adequately mitigate the risks to the environment.

The Agency proposes to cancel all registrations for dicofol because the risks of continued use outweigh the benefits. A 30-day comment period, beginning on the date of the issuance of the Federal Register notice, will allow the Scientific Advisory Panel and the Secretary of Agriculture to review and comment on the Agency's proposed decision, and a 45-day comment period will be given to the registrants, and the public for review and comment. After analyzing these comments the Agency will issue a PD 4 containing the Agency's final decision.

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I. INTRODUCTION

A. LEGAL BACKGROUND

1. Regulatory History

The Federal Insecticide, Fungicide, and Rodenticide Act as amended (FIFRA) and its regulations require the Environmental Protection Agency (the Agency) to review the risks and benefits of the uses of pesticides. On March 21, 1984, the Agency issued a Notice of Special Review (49 FR 10569) of pesticides containing dicofol. The Agency had determined that registrations and applications for registration of pesticide products containing dicofol meet or exceed the risk criteria in 40 CFR 162.11 (a)(3)(ii)(C), which provides that a Special Review (new name for Rebuttable Presumption Against Registration, RPAR) shall be conducted if the use of a pesticide "[c]an reasonably be anticipated to result in significant local, regional, or national population reductions in nontarget organisms, or fatalities to members of endangered species." The "Guidance Document for the Reregistration of Pesticide Products Containing Dicofol as the Active Ingredient" (EPA/540-RS-83-003), issued December 30, 1983, described the Agency's concerns in detail, and also sets forth data and labeling requirements for continued registration of dicofol.

The Notice of Special Review invited comments from the registrants as well as from the public. The comment period lasted 45 days and all comments received were evaluated.

2. Organization of this Position Document

This Position Document 2/3 (PD 2/3) addresses the risks and benefits of the uses of dicofol. This document contains four parts. Chapter I is this Introduction. Chapter II discusses primarily the potential risks of dicofol to wildlife. It includes descriptions and evaluations of the risk information, exposure data, rebuttal submissions and analyses, and the Agency's risk conclusions. It also addresses the carcinogenic risk of dicofol products and their DDT related impurities. Chapter III contains a discussion and quantitative estimate of the benefits of different dicofol uses, and discusses the assumptions and limits of these estimates. Chapter IV describes possible regulatory options to reduce the risks of dicofol, and evaluates the risks and benefits of these regulatory options, and summarizes the regulatory actions which the Agency proposes to take concerning dicofol.

3. The Special Review Process

Issued under FIFRA as amended (7 U.S.C 136-136y), 40 CFR 162.11 provides that a Rebuttable Presumption Against Registration (RPAR or Special Review) shall be conducted if the Agency determines that a pesticide meets or exceeds any of the risk criteria relating to acute and chronic toxic effects set forth in 40 CFR 162.11(a)(3). In making this determination, the Agency is guided by section 3(c)(8) of FIFRA which directs the Agency to begin a Special Review only if it is based on a "validated test or other significant evidence raising prudent concerns of unreasonable adverse risk to man or the environment." If such a determination is made, the registrant(s) will be notified by certified mail and afforded an opportunity to submit evidence in rebuttal to the Agency's presumption. Alternatively, any registrant may voluntarily petition the Agency to cancel the registration of its product(s).

Following the initiation of the Special Review, the pesticide use or uses of concern will enter the public discussions stage of the Special Review process. Registrants and interested members of the public may submit written comments, information, or request public discussions on the Agency's proposed actions and/or other proposals for additional or alternative actions. Registrants may submit information indicating that dicofol does not pose a risk to man or the environment and/or that the benefits exceed the risks associated with dicofol use. Interested members of the public may submit information concerning the risks and benefits associated with the use of dicofol.

If risk issues cannot be resolved through voluntary actions, the Agency proceeds to evaluate the risks and benefits of the pesticide and to propose a regulatory solution in this PD 2/3 and may submit a proposed Notice of Intent to Cancel to the Scientific Advisory Panel and the Secretary of Agriculture. After obtaining comments from the Scientific Advisory Panel, the Secretary of Agriculture, registrants, and the public on PD 2/3, the Agency would issue a Position Document 4 (PD 4) supporting the Agency's final regulatory position, which may include a Notice of Intent to Cancel pursuant to FIFRA, section 6. If the Agency determines that the risks of use exceed the benefits, the Agency would issue a notice of intent to cancel the registration of products intended for such use. The notice may identify for specific uses certain changes in the composition, packaging, and/or labeling of the product which would reduce the risks to levels that the Agency would consider acceptable. Cancellation would become effective unless within 30 days of issuance of the notice, the registrant either requests a hearing to challenge the cancellation or submits an application to amend his product's registration in a manner prescribed in the notice of intent to cancel.

B. CHEMICAL BACKGROUND

1. Chemical and Physical Characteristics

Dicofol is the common name for 1,1-bis(p-chlorophenyl)-2,2,2-trichloro-ethanol. Technical dicofol is a nonflowable liquid (or waxy solid) at room temperature. It ranges from dark brown to yellow brown in color. It is stable under cool and dry conditions, and is practically insoluble in water, but readily soluble in most organic solvents. Its melting point ranges from 58°C to 78°C.

Certain unintentional impurities have been identified in technical dicofol products which are the result of the manufacturing process. The identified contaminants of concern include the p,p' and o,p' isomers of DDT, DDE, DDD (TDE) and "tetra-chloro" DDT (Cl-DDT). The chemical names for these contaminants are as follows:

1. 1,1-bis-(p-chlorophenyl)-2,2,2-trichloroethane [p,p' DDT]
2. 1-(p-chlorophenyl)-1-(o-chlorophenyl-2,2,2-trichloroethane [o,p' DDT]
3. 1,1-bis-(p-chlorophenyl)-2,2-dichloroethylene [p,p' DDE]
4. 1-(p-chlorophenyl)-1-(o-chlorophenyl)-2,2-dichloroethylene [o,p' DDE]
5. 1,1-bis-(p-chlorophenyl)-2,2-dichloroethane [p,p'DDD]
6. 1-(p-chlorophenyl)-1-(o-chlorophenyl)-2,2-dichloroethane [o,p' DDD]
7. 1,1-bis-(p-chlorophenyl)-1,2,2,2-tetrachloroethane [p,p' Cl-DDT]
8. 1-(p-chlorophenyl)-1-(o-chlorophenyl)-1,2,2,2-tetrachloroethane [o,p' Cl-DDT]

In this document, the term DDTr will be used to denote all of these DDT analogs.

2. Registered Uses and Production

The Agency records show registrations for 196 dicofol products and 86 federally recognized intrastate registrations of state-registered products. There are three registrants who are authorized to manufacturer the technical material: Rohm and Haas Company, Makhteshim-Agan (America), Inc., and Aceto Chemical Company.

Dicofol was first registered as a pesticide in 1957. It is used in acaricides to control mites on agricultural crops and ornamentals and in or around agricultural and domestic buildings. Over 77 percent of the active ingredient is applied to five crop groupings: cotton, citrus, dry beans, apples, and field corn. Approximately ten percent of the dicofol is applied to ornamentals throughout the country. The remainder is applied to various minor sites throughout the country.

The active ingredient dicofol is not manufactured domestically, but is imported. Approximately 2.0 to 2.5 million pounds of the active ingredient is used in the U.S. annually.

3. Tolerances

Tolerances for residues of dicofol in or on raw agricultural commodities are listed in 40 CFR 180.163 as follows: 30 ppm in or on hops; 25 ppm in or on peppermint hay and spearmint hay; 10 ppm in or on apricots, grapefruit, kumquats, lemons, limes, nectarines, oranges, peaches, tangerines, 5 ppm in or on apples, beans (dry), snap beans (succulent), lima beans (succulent), blackberries, bushnuts, butternuts, cantaloupes, cherries, chestnuts, crabapples, cucumbers, dewberries (boysenberries and logan berries), eggplant, figs, filberts, grapes, hazelnuts, hickory nuts, melons, muskmelons, pears, pecans, peppers, pimentos, plums (fresh plums), pumpkins, quinces, raspberries, summer squash, strawberries, tomatoes, walnuts, watermelons, winter squash; and 0.1 ppm in or on cottonseed.

The Dicofol Guidance Document required additional crop residue data be developed for dicofol in order to support existing tolerances for dicofol *per se*. Because DDT and related metabolites are impurities present in dicofol, the Guidance Document required that crop residue data also be developed on these compounds. These data could be used by the Agency for further regulatory action on dicofol.

It should be noted that the Agency is in the process of revoking all existing tolerances for residues of DDT and its degradation products (DDE, DDD, and Cl-DDT). The Agency is replacing these tolerances with safe, acceptable residue limits or "action levels". These action levels are needed for enforcement purposes to cover the inadvertent residues of DDT which may be present from the registered uses of dicofol as well as other sources of DDT contamination. This action is being taken because DDT was cancelled in 1972, and the current tolerances may be replaced with lower acceptable residue action levels. The action level will be based on monitoring data from numerous crops including beans, cottonseed, sweet corn, and citrus collected by the Food and Drug Administration (FDA) during the years 1975-1979. Although these data indicate that residues of DDT and its degradation products have been decreasing with time, the actual pesticidal treatment history of the samples analyzed by FDA is unknown. The proposed action levels will be based on survelliance of the raw agricultural commodities including those most commonly treated with dicofol. In the event DDTr is detected above those action levels in crops treated with dicofol, the Agency would take appropriate additional regulatory measures at that time.

II. ASSESSMENT OF RISK AND ANALYSIS OF REBUTTALS

A. INTRODUCTION

This chapter has six parts. The first part reviews the basic conclusions that have been reached concerning the hazards of DDT to the environment. These findings were first published in 1972 when the use of DDT was cancelled by the Agency, and reaffirmed in 1975 after the Agency reviewed the scientific literature since 1972. The second part discusses the residue trends of DDT and its related compounds in areas of high dicofol usage. The potential for exposure to sensitive species in these areas is also discussed. The third part is an exposure analysis that uses mathematical models and calculations to predict the amount of environmental contamination that might result from the normal use of dicofol. The fourth part discusses the oncogenicity of dicofol and DDTr, as well as the toxicology of the alternatives. The fifth part discusses the relative ecological hazards of dicofol alternatives. The sixth part of this chapter is an analysis of the rebuttal comments received by the Agency from the public and pesticide registrants.

1. Review of Agency Findings in its DDT Cancellation Decision

When the Agency cancelled DDT (Ruckelshaus, 1972) it published a series of scientific conclusions regarding the environmental fate and toxicological effects of the pesticide. It was determined at that time that the following chemical properties of DDT exacerbate the potential risk from DDT to the environment:

- DDT can persist in soils for years and even decades.
- DDT can persist in aquatic ecosystems for long periods.
- Because of persistence and other characteristics, DDT is subject to transport from sites of application.
- DDT can be transported by drift during aerial application.
- DDT can vaporize from crops and soils.
- DDT can be attached to eroding soil particles.
- DDT is a contaminant of freshwaters, estuaries and the open ocean and it is difficult or impossible to prevent DDT from reaching aquatic areas and topographically non-adjacent and remote from the site of application.

The activity of DDT in food chains was determined to represent an unknown, unquantifiable risk to man and lower organisms because DDT can be concentrated in and tranferred through terrestrial invertebrates, mammals, amphibians, reptiles, birds, freshwater and marine plankton, insects, molluscs, other invertebrates, and fish.

The Agency found that DDT can have lethal and adverse sublethal effects on useful aquatic freshwater invertebrates, including arthopods and molluscs; that it is toxic to and can affect the reproductive success of fish. Birds can also mobilize lethal levels of DDT residues and sublethal levels can cause chronic problems, i.e., thinning of eggshells and impairment of reproductive success.

Generally, the Agency concluded that no directions for use of DDT, even if followed, could over the long run adequately mitigate DDT's injury to man or other vertebrate animals; that no warning or caution for use of DDT, even if followed, could over the long run prevent injury to living man and other vertebrate animals and useful invertebrate animals; and that use of DDT in controlled situations in limited amounts might present less risk than usage in greater amounts, but still would contaminate the environment.

At the request of the U.S. Congress the Agency undertook a review of the scientific evidence on which the cancellation was based. This review entirely affirmed the scientific judgments made in the cancellation decision and stated that:

"Voluminous literature published in this area since the DDT hearings has allowed a more complete picture of DDT's effects in this area than was available at the time of cancellation. Reproductive, behavioral, lethal, and sublethal effects on fish and wildlife have been reviewed in detail based on the additional literature and data. Also, the Agency conducted intensive onsite field interviews with persons involved in research on fish and wildlife effects to obtain most recent data and results as a supplement to the nearly 500 articles that have been published in this area and reviewed since the cancellation.

New data were available in the case of most findings on fish and wildlife effects and none of the findings of the Agency could be denied on the basis of new data. Certain adverse behavioral effects on wildlife that were not known in 1972 have been established since that time" (Environmental Protection Agency, 1975).

2. Ecological Effects of DDT and DDT Analogs

DDE has been the chemical most thoroughly studied for reproductive effects in wildlife; there is comparatively little data concerning the potency of DDD to various bird species. Environmental effects and fate data for Cl-DDT is unavailable, but the Agency believes that this analog is potentially a DDE precursor and could lead to adverse effects. Thus, although the following discussion focuses on DDE, the Agency is for how thinning occurs in susceptible species but not in chickens or other non-susceptible species is the biochemical mechanism...

5. No other chemical has been shown to produce the degree and duration of shell thinning produced by DDE.

For all these reasons, the Agency concludes that DDE can cause thinning of bird eggshells, thus impairing reproductive success. This phenomenon has been so general and widespread as to present serious environmental risk to the many avian species involved."

Derek Ratcliffe in his 1967 paper "Decrease in eggshell weight in certain birds of prey", first identified the correlation between the use of organochlorine insecticides and reproductive failure and eggshell thinning in wild raptors. Subsequent studies identified eggshell thinning in numerous species in North America (Anderson and Hickey, 1972) and correlated reductions in eggshell thickness with DDE levels in the eggs of brown pelicans (Blus et al., 1972), white pelicans, great blue herons (King et al., 1978), peregrine falcons (Cade et al., 1971), sparrowhawks (Newton, 1973), ospreys (Wiemeyer et al., 1975), black ducks (Longcore and Stendell, 1983), and other bird species (Stickel, 1975). Significant population reductions in bald eagles (Grier, 1982), ospreys (Spitzer et al., 1978), prairie falcons (Pimentel, 1971), and brown pelicans (Blus, 1982) have been linked to these reproductive effects. The extinction of the American peregrine falcon as a breeding species east of the Rocky Mountains has been primarily attributed to use of DDT (U.S. Department of Interior, 1979A).

The causal link between DDE and avian reproductive effects is clearly supported by a series of laboratory studies showing that, under controlled conditions, low dietary exposures of DDE have statistically significant effects on eggshell thickness and egg viability. Heath et al. (1969) provided the first laboratory documentation that DDT and DDE caused thin eggshells. In an experiment with mallards spanning two breeding seasons, DDE at a concentration of 3 ppm (wet weight basis) thinned eggshells 11 percent, increased cracking 5-fold, and reduced survival of uncracked, embryonated eggs by 50 percent. Haegele and Hudson (1974) showed that shell thinning in mallards persisted 11 months after cessation of DDE exposure. In black ducks, Longcore and Stendell (1983) report shell thinning at dietary concentrations as low as 0.6 ppm (wet weight). In earlier work (1977) these authors showed that a dietary concentration of 3 ppm reduced shell thickness 20 percent and that eggs remained significantly thinner (ten percent) than controls up to two years post-treatment. Reproductive performance was significantly impacted in ring doves fed a diet containing 40 ppm DDE (dry weight): treated doves took an average of 2.5 times longer to renest than controls, produced 13.5 percent fewer eggs/clutch, had ten percent thinner eggshells, and experienced twice as great juvenile mortality (Haegele and Hudson 1973). Shell thinning in wild populations has been particularly severe in predatory birds (Anderson and Hickey, 1972). Laboratory testing with the American kestrel, a small falcon, showed that a dietary concentration of 2.8 ppm (wet weight) DDE caused a 9.7 percent decline in mean shell thickness (Wiemeyer and Porter, 1970). Mendenhall et al., (1983) fed barn owls a diet containing 3 ppm DDE. This exposure caused eggshell thinning (20 percent), egg breakage, embryo mortality, and reduced production per pair. Screech owls fed 2.8 ppm DDE (McLane and Hall, 1972) also showed significant shell thinning (13 percent).

It is significant from a risk assessment standpoint that chronic no-effect levels for DDE to sensitive wildlife are not well established. Most laboratory studies have reported effects at the lowest treatment level. This is important because environmental residue monitoring shows that DDE is ubiquitous and that continuous low-level (0.01-0.5 ppm) dietary exposure will occur for many species. Laboratory research with black ducks (Longcore et al., 1971, Longcore and Stendell, 1983) has demonstrated that a dietary exposure of 0.6 ppm caused statistically significant reproductive impairment; this exposure was considered a near "threshold" level. For black ducks this particular threshold may be meaningful but chronic DDE effects will vary species to species based on differences in sensitivity. For example, black ducks and barn owls have both been tested at a dietary concentration of 3 ppm. This exposure thinned black duck eggshells 17.6 percent, but thinned barn owl eggshells 28 percent. Black ducks were tested at a lower concentration (0.6 ppm) but barn owls were not. If it is assumed that responses will be proportionally similar at lower doses, barn owl eggshells would be reduced 13 percent at 0.6 ppm, black ducks were eight percent thinner at this level. Moreover, laboratory exposures have generally been for one to two laying seasons while actual exposures may occur over far greater time periods (5-15 years are not uncommon ages for many of the larger bird species). Thus estimations of effect thresholds or no-effect levels must be made cautiously, particularly for endangered species with a history of DDT effects.

Field monitoring studies lack controlled or precisely known exposure information. Nonetheless, important inferences about dietary concentrations of DDE toxic to birds can be made from them:

(1) Bald eagles in Maine from 1962 to 1970 had young in only 26 percent of their nesting attempts and produced an average of 0.35 young per active nest (production of 0.7 young per nesting attempt was estimated as the minimum required for population stability [Sprunt et al., 1973]). Bald eagle eggs collected in Maine between 1969-1979 had shells 13 percent thinner than pre-DDT era specimens (Wiemeyer et al., 1984).

Fish and eels comprise 90 percent of the bald eagle diet in Maine, with birds, mostly ducks, making up the remainder of their food (Wiemeyer et al., 1978). Mean DDE (calculated per site) in fish and eels (Table II-1) collected in Maine (1966 and 1974) ranged from 0.05 ppm to 0.23 ppm. Heath and Hill (1974) report DDE residues in black duck wings in Maine at 0.48 ppm in 1966 and 0.60 ppm in 1969.

(2) Field monitoring by Blus (1982) showed that Eastern brown pelicans have pronounced reproductive impairment when egg residues are 3 ppm DDE. Total nest failure occurs at roughly 4 ppm DDE. Comparison of residues in fish and eggs by Blus et al. (1977) suggested there is a 31x relationship between DDE in pelican food (menhaden) (Table II-2) and that in fresh eggs. This bioaccumulation factor (food to eggs) indicates reproductive effects for this population possibly occurring at dietary levels ≥ 0.096 ppm DDE (3 ppm divided by 31).

(3) California brown pelicans experienced drastic reproductive effects in the 1960's. Anderson et al. (1975) studied eggshell thickness, egg residues and dietary-pesticide exposures (anchovies) (Table II-3) in brown pelicans on Anacapa Island and Isla Coronado Norte. Residues were very high in anchovies in 1969 (3.24 DDE; 4.27 ppm DDTr) but fell sharply with the reduction in DDT discharge from the Los Angeles sewer system after 1970. Anchovy residues (DDE) were 0.84 in 1970, 0.74 in 1972 and 0.12 ppm respectively, by 1974. Eggshell thinning correspondingly fell from 30 percent (intact eggs) in 1969 to 17 percent in 1974. Pelican reproduction had much improved by the early 1980's but eggshell thinning persists in a portion of the population (Gress, 1984), presumably even though DDE dietary levels have fallen to 0.10 ppm or less.

(4) Thompson et al. (1977) collected fish regurgitated by wild pelicans in Florida in 1970-71 to estimate dietary exposures. Fish obtained, by species, had DDE residues ranging from 0.004 to 0.033 ppm (wet weight, whole fish) with a mean of 0.017 ppm. Total DDT homologs were present at (mean) 0.051 ppm. Forty-three eggs collected had an overall mean of 0.9 ppm DDE and DDTr of 1.32 ppm (wet weight). Food to egg bioaccumulation was 52.7x for DDE and 25.8 for DDTr. Blus (1970) measured eggshell thickness in 12 pelican colonies in Florida during this period (1969) finding reductions of 5.9 percent in Gulf coast colonies and 9.0 percent for Atlantic coast colonies.

(5) Pruett-Jones et al. (1981) measured residues of DDTr in eggs and shell thickness in peregrine falcons in Australia. Their research also included measurement of DDTr in 14 species of birds considered representative prey of peregrines. DDE residues in eggs ranged from 2.3-82 ppm. Shells were estimated to be 20.4 percent thinner than eggs collected prior to 1952. Prey species averaged 0.11 ppm DDE. Most commonly eaten species by peregrine were the feral pigeon (DDE = 0.05, DDTr =

Table II-1 DDE and DDTr residues in potential bald eagle food items in Maine, 1966-1974 (Wiemeyer et al., 1978).

County Area	Year	PPM, Wet Weight DDE GM[1]	PPM, Wet Weight DDTr GM[1]	Sample Composition
Washington	1966	0.17	—[2]	Fish
Washington	1974	0.05	—[2]	Fish and eel
Hancock	1966	0.14	0.54	Fish
Penobscot	1974	0.05[3]	—[2]	Eel
Lincoln	[illegible]6	0.23	0.42	Fish and eel
Lincoln	1974	0.09	0.20	Fish and eel
Lincoln, Sagadahoc Washington	1966	3.22	—[2]	Herring gulls

DDE Fish Range (Geo. means) = 0.05 - 0.23

DDTR Fish Range (Geo. means) = 0.20 - 0.54

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[1] Geometric means. Samples with no detectable residue were included as 0.025 ppm (1/2 the limit of sensitivity).

[2] DDD and DDT were largely or entirely non-detectable.

[3] Single composite sample, not a geometric mean.

Table II-2 Residues of DDE and DDTr in Atlantic menhaden regurgitated by brown pelicans in South Carolina, 1973 (Blus et al., 1977).

	PPM, Wet Weight	
	DDE	DDTr
	0.04	0.12
	0.06	0.15
	0.07	0.12
	0.06	0.12
	0.05	0.10
	0.08	0.13
	0.15	0.28
Geometric Means	0.067	0.138

Table II-3 Eggshell thickness, egg residues and dietary-residue exposure in California brown pelicans (1969-1974) (Anderson et al., 1975).

DDTr residues are PPM wet weight basis.

Year	Anchovy Residue		Egg Residue[1]		Percent Shell Thinning	
	DDE	DDTr	DDE	DDTr	Broken Eggs	Intact Eggs
1969	3.24	4.27	(I)[2] 37.5 (C)[3] 50.8	39.9 53.0	50	31
1970	.84	1.40			50	32
1971	.87	1.34			46	20
1972	.74	1.12	9.72	Not Measured	49	24
1973	.18	.29	7.7	8.05	41	12
1974	.12	.15	4.25	4.25[5]	35	17
1975[4]			4.97[5]		37	11

[1] Original data reported ppm lipid. Conversion to wet weight based on egg lipid content of 4.4% (Blus 1982).

[2] Intact eggs

[3] Cracked eggs

[4] Anderson et. al. 1977

[5] DDT and DDD not detected

0.06 ppm wet weight) and the common starling (DDE = 0.13, DDTr = 0.13 ppm wet weight).

(6) Eggshell thinning and organochlorine residues in peregrine falcons and their prey were studied by Enderson et al. (1982) in Colorado and Northern New Mexico (1973-79). Eggshells in 141 eggs averaged 16 percent thinner than pre-1947 eggs for this species. A sample of 47 eggs for this species contained a mean of 20 ppm DDE. Among 12 prey species frequently taken by peregrine in the area, DDE residues ranged from 0.04 to 6 ppm (wet weight) with a geometric mean of 0.32 ppm (arithmetic mean = 0.88 ppm DDE).

These data suggest that chronic dietary exposures below 0.5 ppm, and perhaps below 0.1 ppm, may cause eggshell thinning or otherwise adversely affect reproduction in sensitive avian species (Blus, 1984). Sections B and C of this report will demonstrate that avian food chains in major dicofol use areas are contaminated with DDTr at or above these concentrations.

b. Behavioral Effects on Birds

The relationship of DDE to physiological effects such as thinning of eggshells has been extensively studied. DDE has also been linked to abnormal behavior that is more difficult to document in wild populations but that may also reduce productivity. · Ratcliffe (1970) observed peregrines eating their own eggs and speculated (1972) that pesticide-induced behavioral disturbances may be important in egg losses. Synder et al. (1973) studied productivity of wild Cooper's hawks. They found broken eggs that had thin eggshells but also found egg breakage when shells were not exceptionally thin; high DDE content occurred in all cases, however. This fact suggested that the pesticide contributed to egg loss in ways other than just by shell thinning. Their observations of poorly constructed nests and of a female Cooper's hawk inability to properly feed its young suggested possible behavioral effects.

In controlled DDE-dietary studies, behavioral effects related to reproduction have been reported. Risebrough and Anderson (1975) found that mallards given a diet containing 40 ppm DDE and 40 ppm PCB had significantly greater egg losses than either controls or mallards exposed to DDE or PCB (40 ppm) separately; losses were primarily from parental egg-eating. Wiemeyer and Porter (1970) found that egg disappearance in kestrels receiving a diet containing 3 ppm DDE was significantly greater than in control birds. Haegele and Hudson (1977) found that DDE in the diets (10 and 40 ppm) of ringed turtle doves suppressed courtship behavior and increased (2.5x) the time to renesting (Haegle and Hudson, 1973). Body residues in experimental birds were lower than in some wild species that experienced reproductive failure suggesting such that effects may be occurring in contaminated-populations.

Heinz (1976) found that offspring of mallards fed a diet containing 3 ppm DDE (0.6 ppm wet weight equivalent) were hypersensitive to maternal calls (more approached the call and more stayed near the call than controls). In testing of avoidance response, Heinz found offspring of DDE-treated mallards travelled a shorter distance from a frightening response. Because the eggs of mallards that received DDE laid eggs containing residues similar to those in eggs of some wild birds, Heinz suggested DDE-induced behavioral effects may be occurring in nature.

c. Effects on Fish Reproduction

Poor viability in hatchery-raised lake trout in New York state lead to the discovery that DDT can have pronounced reproductive effects on fish (Dean, 1963). Hatchery reared eggs, obtained from wild trout in Lake George, showed extensive mortality. An intensive follow-up study (Burdick et al., 1964) revealed that a large proportion of sac-fry died if they contained 2.9 ppm DDT and DDD, and all died when the concentration was 5 ppm. DDT residues were attributed to spraying for forest insects near Lake George. Similar instances of DDT-related hatchery mortality were reported in speckled, rainbow and cut-throat trout in Canada (Cuerrier et al., 1967), in salmon in Maine (Anderson and Everhart, 1966, Locke and Havey, 1972) and in rainbow trout in New Zealand (Hopkins et al., 1969, Dacre and Scott, 1971).

Macek (1968) held laboratory brook trout on DDT-treated feed and similarly found sac-fry mortality. Macek concluded that residues in female brown trout in his study were similar to those in wild trout in areas sprayed with DDT for forest insect control and that reductions in trout fry populations could be occurring.

In 1969, studies correlated residues of DDT in sea trout in Texas (Laguna Madre) with those in menhaden, a major food of sea trout. Reproductive failure had been observed since 1964, with young declining from 30 to 0.2 juvenile trout per acre. In following years, residues in menhaden sharply declined and the sea trout populations returned to 1964 levels.

Smith and Cole (1973) exposed adult winter flounder to filtered seawater containing (in separate exposures) 2 ppb DDT, 1 ppb DDT + 1 ppb dieldrin and 2 ppb dieldrin. Developing eggs in DDT-exposed fish showed abnormal gastrulation and 39 percent of larvae at-hatching had vertebral deformities. Bone erosion and hemorrhaging at vertebrate junctures were observed in eggs in higher DDT concentrations (greater than 2.39 ppm). Deformities in control and dieldrin groups were greater than one percent DDT. DDT residues in eggs ranged from 0.39 to 4.6 ppm with a mean of 2.42 ppm; the rate of mortality in developing eggs was positively correlated with DDT residues.

Scott and Crossman (1973) suggested that DDT-induced reproductive failure played a major role in the decimation of the commercial lake trout fishery in the Great Lakes. Field research by the U.S. Fish and Wildlife Service and other groups (U.S. Department of the Interior, 1981) indicates that lake trout are not reproducing in Lake Michigan though stocked lake trout survive in the lake. In laboratory experiments, fry hatched from eggs of Lake Michigan lake trout were exposed to PCB and DDE concentrations similar to those found in water and plankton in Lake Michigan to determine if ambient levels of these contaminants may be affecting productivity. Based on environmental residues, the researchers established laboratory water exposures of 1, 5, and 25 ng/L (ppt) DDE and 10, 50 and 250 ng/L PCB. Fish diets were also treated and were, correspondingly, 0.1, 0.5 and 2.5 ppm DDE and 1, 5 and 25 ppm PCB. DDE and PCB esposures were run separately and in concert. Mortality among fry in all DDE and DDE + PCB exposures was significantly ($P<0.05$) greater than in controls. The mortality in the two lowest PCB concentrations was greater than in controls but not statistically significant. By the end of the study, the total cumulative mortality ranged from 30.5 to 46.5 percent in exposed groups and was 21.7 percent in the control group. The researchers concluded that "because fry exposed to the 1x PCB + DDE concentration received contaminant doses similar to those experienced by lake trout fry in Lake Michigan, the difference in final mortality between these fry (40.7 percent) and control fry (21.7 percent) is particularly important."

d. Accumulation of DDE in Birds Fed Diets Containing Dicofol

Heinz et al. (unpubl.) fed 14-day old bobwhite diets containing different amounts of either DDT or dicofol for a period of 6-weeks:

Pesticide	Dietary Concentrations (nominal)
DDT	0, 5, 10, 25, 50, 100
Dicofol	0, 25, 50, 125, 250, 500

At the conclusion of the test, bird livers were analyzed for DDTr compounds. Results showed that DDE accumulated in the livers of all birds fed dicofol. The researchers observed that:

> "The lack of dicofol and high levels of DDE in the livers of birds fed dicofol was surprising. As a check, we prepared the carcasses and livers of 2 additional quail that had been fed dicofol for 2 weeks. The livers contained 9.9 and 10 ppm DDE, no dicofol, and 1.7 and 1.2 ppm p,p'-DCBP. The carcasses contained 9.4 and 5.2 ppm DDE, 28 and 17 ppm dicofol, and no p,p'-DCBP. From this we conclude two things: 1) we cannot detect dicofol in the liver, and 2) high levels of DDE resulted from feeding dicofol. The small amounts of DDE found as a contaminant of dicofol diets probably could not

account for the high levels of DDE in livers. For example, only 3 ppm DDE was found in the diet mixed to contain 500 ppm dicofol, but livers from birds fed this diet contained an average of 36 ppm DDE. Livers of birds fed 100 ppm DDT contained an average of only 11 ppm DDE. At the present time, we cannot explain the high residues of DDE in the livers of birds fed dicofol, but is is possible that the changes in liver or blood chemistry we found were the result of DDE not dicofol."

Using the data of Heinz et al., a comparison was made of the relative accumulation of DDT-compounds in bobwhite livers at equal dietary exposures of DDT and dicofol (Table II-4). This comparison shows that birds exposed to dicofol acquired DDTr at levels 15-51 percent that of birds exposed to equal concentrations of DDT. Heinz et al., as a check on their initial results, analyzed two bobwhite that were fed dicofol (500 ppm) for two weeks (previous groups were fed six weeks). These birds likewise accumulated DDE in their livers (9.9 and 10 ppm). Carcass concentrations were reported for these check-samples and were similar to the liver residues (9.4 and 5.2 ppm).

This experiment does not define residue uptake sufficiently to allow discrimination between several alternative explanations for the high DDE accumulation in dicofol-fed birds. However, the presence of other DDE precursors at high levels in dicofol (i.e. Cl-DDT) or even metabolism of dicofol to DDE are possibilities that require investigation.

The accumulation of DDE in quail carcasses, at levels similar to those in liver, increases the possibility that birds feeding regularly in treated areas may accumulate sufficient DDE to pose a hazard to higher trophic level species. The data here are only suggestive but the lower dicofol exposure levels in this experiment (25 to 50 ppm dry weight; six to 12 ppm estimated weight wet equivalent) are within the range expected immediately following treatment at the higher application rates (two to three pounds active ingredient per acre) (Kenaga, 1973). Birds in these exposures had liver residues, and possibly carcass residues, of 1.5 to 2 ppm.

3. National Trends in Residues of DDT and its Related Compounds in Fish and Wildlife

Since 1967, fish and birds have been periodically sampled for residues of DDT and its related compounds in the United States as part of the National Pesticide Monitoring Program (NPMP). Legal use of DDT was largely stopped by the Agency's 1972 ban, and NPMP monitoring since then has indicated general reductions in DDTr residues. Residues in several regions, however, are stable or declining slowly and exceed levels considered potentially harmful.

Table II-4 Comparison of DDTr accumulation in livers of bobwhite fed similar dietary concentrations of dicofol and DDT (Heinz et al., unpub.)

Pesticide	Nominal Dietary Exposure	DDE in Livers	DDTr in Liver - PPM	DDTr in liver from Dicofol as % of DDTr in liver from DDT
Dicofol	25	1.45	1.45	51%
DDT	25	1.65	2.83	
Dicofol	50	1.97	1.97	20%
DDT	50	4.33	7.84	
Dicofol	125	3.63 (2.9)[1]	3.63 (2.9)[1]	15%
DDT	100	10.98	19.48	

[1] Adjusted to 100 ppm dicofol

a. Fish

As part of the NPMP, freshwater fish of various species have been periodically collected at over 100 designated stations throughout the U.S. These data show that the concentration of DDT and related compounds in fish has declined significantly since 1969 (Figure II-1) (Schmitt et al., 1983), but DDE is still being detected at each station. These data, however, also suggest that DDE residues may have stabilized as analysis of variance indicates that differences between national averages determined in 1976-77 (0.40 ppm) and 1978-79 (0.37 ppm) were not statistically significant. Differences between 1974 (0.57 ppm) and 1976-79 were highly significant.

Schmitt et al. in reviewing the most recent set of fish monitoring data (1978-79), concluded that the whole-fish residues considered "are representative of the contaminant levels to which piscivorous fish and wildlife would be exposed and can therefore be compared with the following criteria established by the National Academy of Science (NAS) and National Academy of Engineers (NAE) for the protection of fish-eating wildlife: DDT and its metabolites, 1.0 mg/kg (total)." Moreover, they found that the criterion for DDT and metabolites was exceeded by at least some or all samples at over 10 percent of the stations monitored in 1978-79. They also concluded, "the ubiquity of DDT and its metabolites highlights the persistence and mobility of these toxic compounds."

b. Birds

Starlings have been monitored for organochlorine residues at over 110 sites in the United States since 1967-68. Recent monitoring results (Cain and Bunck, 1983) found DDT residues in only four samples, but DDE, a persistent metabolite of DDT, was found at 111 of the 112 sites. Starlings collected from 14 (12.5 percent) sites had greater than 1 ppm (ug/g) DDE and seven of these sites had DDE residues consistently above 1 ppm in previous sampling periods (Table II-5). This analysis also indicated that DDE residues, as a nationwide trend, significantly decreased between 1976 (0.24 ppm) and 1979 (0.17 ppm) (1979 is the most recently published survey) and reflected the pattern of decline in DDE in starlings since the beginning of the monitoring program (Table II-6). Partial results of the unpublished 1982 survey (Bunck, 1984) were received from the U.S. Fish and Wildlife Service. These data show that mean nationwide DDE-residues in starlings declined numerically between 1979 (0.17 ppm) and 1982 (0.15 ppm), but the difference was not statistically significant. Though mean residues have not declined consistently with each sampling period in the past, the 1982 data suggest that residue dissipation may be 'leveling off' and that residue losses in the second decade after cancellation of DDT may be much slower than in the first decade since the ban.

Wings of hunter-shot mallards and black ducks have also been monitored in the NPMP. The most recently reported survey

Figure II-1 DDTr residues in freshwater fish. National Pesticide Monitoring Program (Schmitt et. al., 1983)

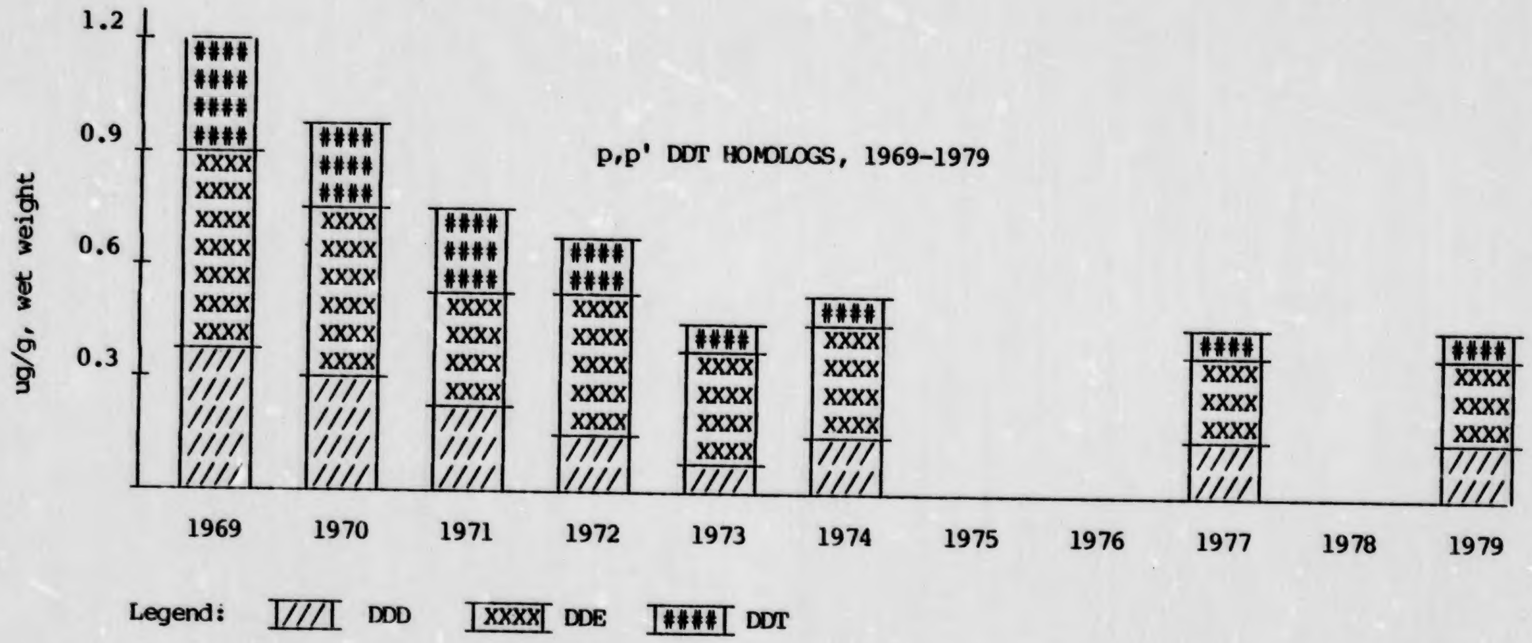

Table II-5 Historical mean residue levels in starlings from 14 collection sites that had greater than 1.0 ppm DDE in the 1979 collection. (Cain and Bunck, 1983)

State	Site	1979	1976	1974	1972	1970
Arizona	4-C-1	6.44	5.00	9.11	0.13	14.80
Arkansas	3-G-3	1.27	11.10	9.11	7.95	5.24
California	3-A-1	2.11	1.26	3.65	1.90	3.59
California	3-A-3	1.46	2.20	1.04	0.30	0.77
California	3-B-4	1.68	3.14	1.04	2.31	2.75
California	4-B-1	2.72	7.41	2.71	1.44	2.11
Minnesota	1-G-1	1.06	0.05	NS	NS	0.96
New Mexico	4-D-2	2.67	1.71	0.94	0.63	NS
New Mexico	4-D-3	15.80	12.40	3.70	3.52	1.45
North Carolina	3-I-2	1.27	NS	0.40	1.09	0.77
North Carolina	3-J-1	1.49	1.21	0.65	1.11	0.32
South Carolina	4-I-1	2.26	NS	1.88	5.04	3.00
Tennessee	3-H-3	1.41	0.09	0.11	0.44	0.32
Texas	4-E-3	1.42	1.05	0.49	2.06	NS

Table II-6 Nationwide Starling Residues Geometric Means (NPMP)

Year	No. Pools	DDE, ppm Geom. Means
1970	125	0.355
1972	130	0.387
1974	126	0.229
1976	106	0.24
1979	106	0.17
1982	129	0.15

(1979-80) (Cain, 1981) showed that DDE was found in all samples (215 pools, drawn from 5268 wings) ranging from 0.02 ppm (Florida, Kentucky) to 3.28 ppm (Arizona, Western New Mexico). DDE residues have declined since 1969, but declines were most pronounced in early monitoring (White and Heath, 1976, White, 1979) (Table II-7) 1969-1972. DDE levels did not significantly decrease between 1976 and 1979 in any of the flyways and in the Pacific Flyway DDE increased 59 percent (0.22 ± 0.04 ppm to 0.35 ± 0.08) but this difference was not statistically significant.

Table II-7 DDE residues (ppm) in duck wings by year and flyway.

Species	Flyway	1969[1]	1972[1]	1976[2]	1979[2]
Black	Atlantic	1.32	0.35	0.39	0.32
Mallard	Atlantic	1.03	0.44	0.32	0.27
	Mississippi	0.40	0.37	0.25	0.17
	Central	0.30	0.15	0.28	0.10
	Pacific	0.71	0.34	0.22	0.35

[1] White and Heath, 1976

[2] Cain, 1981

B. DICOFOL USE AREAS: RESIDUE TRENDS AND POTENTIAL EXPOSURE TO SENSITIVE WILDLIFE SPECIES

An Agency investigation of recent dicofol usage estimated current nationwide application of approximately 2.5 million pounds (active ingredient) per year. The use of dicofol is concentrated geographically in California, Florida, Texas and Arizona (greater than 70 percent of total use).

In the following sections, states with major dicofol use will be discussed in relation to reported DDTr residues in wildlife and potential exposure of sensitive animal species.

1. California

Usage data, though reported to be incomplete, indicate that California leads the nation in dicofol use with 1981/82 applications totalling 1,029,700 pounds of active ingredient or 37 percent of total U.S. use. Major crop uses are as follows:

Crop	Pounds active ingredient
oranges	36,500
lemons	36,700
dry beans	88,000
corn	88,000
alfalfa	51,600
melons	49,300
grapes	21,300
cotton	634,600

Dicofol DDTr-contamination levels are not precisely known. A Rohm and Haas product composition report received by the Agency on May 21, 1981 indicates that technical dicofol (85 percent active ingredient) contains DDT, DDE, DDD, and tetrachloro-DDT (Cl-DDT), collectively known as DDTr. The estimated 1,029,700 pounds active ingredient used in California 1981/82 is equivalent to 1,211,412 pounds of technical material (which is 85 percent dicofol). The technical contamination levels reported by Rohm and Haas suggest dicofol use in California may result in annual release of over 120,000 pounds or 60 tons annually of DDTr (assuming a ten percent contamination level).

a. Environmental Residues

Monitoring studies of pesticide residues in California fish and wildlife indicate that DDE, the persistent metabolite of DDT, is ubiquitous. DDT use in California was extensive prior to 1972 and undoubtedly much of the past and present residues in animal samples are from this source (California State Resource Control, 1977). Nonetheless, the DDTr in dicofol will also contribute to these residues.

As discussed in Section A, NPMP monitoring of DDE residues in starlings has shown a pattern of decline nationally since the early 1970's. In California nine sites have been monitored consistently and data from these sites show that residues in California exceed the national average (Table II-8). Of the sites in the United States currently having high DDE residues, four are located in California (see Table II-5); these four sites in California have consistently had residues above 1 ppm (wet weight) since 1970 (Figure II-2).

Dicofol is used in these areas (Table II-9), but no correlation is apparent between current use estimates (by county) and starling residues. This is not unexpected as the majority of DDE residues probably result from past DDT use, the areas considered are large and the relationship of sample collection sites to dicofol use areas is unknown, and both starlings and DDTr are mobile in the environment. To the extent that starlings reflect DDE trends in other small avian species, it is significant both that residues are not rapidly dissipating and that these levels are above levels chronically toxic to higher food chain species.

DDE residues in mallard wings have been monitored in California since 1966 in NPMP surveys. Reported residues (Heath and Hill, 1974; White and Heath, 1976; White, 1979A; and Cain, 1981) have declined with each monitoring study since 1966 (Table II-10). The temporal pattern shows stable mean residues between 1966 and 1969 (1.45 ppm vs 1.52 ppm DDE) with a large drop subsequently occurring between 1969 and 1972 (0.60 ppm). Since 1972, the rate of decline has slowed to the point where there is no significant difference between the 1976 mean and the 1979 mean. Confidence that a continual decline will occur is undermined by the sizable increases in state mean values between 1976 and 1979 in the Pacific Flyway states of Colorado, Oregon, Arizona and New Mexico and the increase in pooled Pacific Flyway values in the interval (1976 $\bar{x}$ = 0.22 ppm; 1979 $\bar{x}$ = 0.35 ppm DDE) (Table II-11).

DDT residues in freshwater fish have been routinely measured in California by both state and Federal monitoring programs. Sampling at two locations (Table II-12) in the central valley through the the National Pesticide Monitoring Program

Table II-8 NPMP residues (DDE, geometric means) in starlings in California and U.S., 1967-1979. Values are ppm wet weight.

Sampling Year	U.S.	California
1967-68	0.579	1.013 (Fall)*
1970	0.355	0.912
1972	0.387	0.77
1974	0.229	1.09
1976	0.254	0.96
1979	0.17	0.66
1982	0.15	0.42

*First surveys were at different times throughout the year. Lipids varied seasonally, therefore, fall samples (November 1968) were used for comparison to later years which were all November-December.

Table II-9 Organochlorine residues in starlings at NPMP sites monitored in 1979 (Cain and Bunck, 1983).

County	Nearest Town	Site	Residues - ppm Wet Weight DDE	 DDT	Dicofol Use (lbs. a.i.) by county 1981/82
Monterey	Gonzales	3-A-3	1.46	ND[1]	3800
Inyo	Bishop	3-B-1	0.57	ND	-
Kern	Buttonwillow	3-B-4	1.68	ND	156,100
Imperial	Holtville	4-B-1	2.72	ND	44,600
Colusa	Maxwell	2-A-1	0.30	ND	23,600
Shasta	Redding	2-A-2	0.12	ND	-
Modoc	Alturas	2-A-3	0.67	ND	-
Ventura	Ventura	3-A-1	2.11	ND	34,400
Stanislaus	Modesto	3-A-2	0.12	ND	37,000

[1] Not detected

Table II-10 DDE Duck wing residues in California (NPMP).

	Mean				
Year	PPM	DDE (S.E.)	Range	No. Pools	% Change
1965-66	1.45	(± .17)	0.02 - 3.50	11	-
1969	1.52	(.19)	0.99 - 2.7	8	+5%
1972	0.60	(.19)	0.30 - 2.3	10	-61%
1976-77	0.44	(.12)	0.15 - 1.18	10	-27%
1979-80	0.34	(.1)	0.06 - 0.72	6	-23%

Table II-11 DDE in Mallard wings - Pacific Flyway (NPMP)

Year	PPM DDE	SE	No. Pools
1966	0.70	0.063	117
1969	0.71	0.054	51
1972	0.34	0.043	55
1976	0.22	0.04	50
1979	0.35*	0.08	44

* Residue increases found in Oregon (0.25 to 0.57), Colorado (0.13 to 0.60), and Arizona and New Mexico (0.33 to 1.22).

Table 12. DDTR residues in fish at 2 NPMP stations in California.
(Unpublished data - L. Ludke, USFWS, Columbia, Mo)

STATION 39, SACRAMENTO RIVER AT SACRAMENTO, CA

ID	YEAR	SPECIES	MEAN TL (CM)	MEAN WT (KG)	LIPID (%)	P,P'-DDT ---HOMOLOGUES---- DDE	DDD	DDT
1	69	COMMON CARP	32.8	0.4	4.1	0.94	0.32	0.08
2	69	LARGEMOUTH BASS	27.4	0.3	1.8	0.30	0.18	0.16
3	69	WHITE CATFISH	35.8	0.6	5.6	0.86	0.32	0.21
4	70	COMMON CARP	27.7	0.4	2.2	2.92	0.37	0.09
5	70	IAG RE-ANALYSIS	-	-	3.3	1.14	0.64	0.00
6	70	COMMON CARP	31.2	0.5	7.2	3.58	1.15	0.34
7	70	Q/A RE-ANALYSIS	-	-	7.6	1.44	1.12	0.01
8	70	LARGEMOUTH BASS	30.2	0.5	3.1	2.51	1.30	0.33
9	70	WHITE CATFISH	21.1	0.1	4.7	1.46	0.57	0.40
10	71	COMMON CARP	33.0	0.6	8.8	2.43	0.78	0.18
11	71	Q/A RE-ANALYSIS	-	-	10.0	6.44	1.72	0.22
12	71	IAG RE-ANALYSIS	-	-	11.1	0.69	1.94	0.00
13	71	COMMON CARP	32.3	0.6	9.5	3.26	0.81	0.16
14	71	LARGEMOUTH BASS	31.7	0.6	5.2	0.86	0.43	0.19
15	71	LARGEMOUTH BASS	28.7	0.5	3.9	1.03	0.68	0.13
16	71	WHITE CATFISH	23.1	0.2	6.6	1.04	0.41	0.16
17	71	WHITE CATFISH	23.9	0.2	5.9	0.58	0.25	0.13
18	72	COMMON CARP	29.5	0.5	4.6	1.20	0.30	0.01
19	72	Q/A RE-ANALYSIS	-	-	4.6	1.67	0.34	0.03
20	72	COMMON CARP	29.2	0.5	6.4	2.00	0.60	0.01
21	72	LARGEMOUTH BASS	28.7	0.4	5.1	2.30	0.87	0.15
22	72	WHITE CATFISH	25.9	0.2	6.5	3.50	0.60	0.10
23	73	COMMON CARP	47.8	1.3	12.4	3.20	0.51	0.00
24	73	IAG RE-ANALYSIS	-	-	8.4	3.66	0.86	0.00
25	73	COMMON CARP	51.6	1.9	9.0	1.70	0.40	0.00
26	73	WHITE CATFISH	30.0	0.3	2.6	1.20	0.24	0.00
27	73	Q/A RE-ANALYSIS	-	-	3.3	0.99	0.18	0.06
28	74	COMMON CARP	42.2	0.6	7.5	2.20	0.68	0.00
29	74	Q/A RE-ANALYSIS	-	-	7.7	0.30	0.20	0.03
30	74	IAG RE-ANALYSIS	-	-	11.4	0.26	0.62	0.00
31	74	LARGEMOUTH BASS	29.7	0.4	5.7	1.10	0.43	0.09
32	74	LARGEMOUTH BASS	29.7	0.4	6.5	1.10	0.40	0.09
33	74	WHITE CATFISH	25.4	0.2	6.2	1.20	0.29	0.10
34	77	GOLDFISH	31.5	0.6	6.0	0.69	0.19	0.00
35	77	GOLDFISH	25.9	0.3	7.1	0.54	0.22	0.00
36	77	IAG RE-ANALYSIS	-	-	7.1	0.54	0.22	0.00
37	77	LARGEMOUTH BASS	31.7	0.5	5.0	0.46	0.13	0.00
38	79	BROWN BULLHEAD	-	-	2.3	0.23	0.09	0.03
39	79	LARGEMOUTH BASS	-	-	4.0	0.25	0.08	0.01

STATION 40, SAN JOAQUIN RIVER AT LOS BANOS, CA

ID	YEAR	SPECIES	MEAN TL (CM)	MEAN WT (KG)	LIPID (%)	P,P'-DDT ---HOMOLOGUES---- DDE	DDD	DDT
1	69	BLACK CRAPPIE	26.4	0.3	6.1	0.62	0.49	0.25
2	69	COMMON CARP	37.3	0.6	2.0	0.86	0.40	0.14
3	69	CHANNEL CATFISH	40.9	0.5	5.7	0.78	0.58	0.21
4	70	BLACK CRAPPIE	29.5	0.5	9.5	0.70	0.84	0.44
5	70	Q/A RE-ANALYSIS	-	-	9.6	0.34	1.00	0.71
6	70	BLACK CRAPPIE	27.4	0.5	8.7	0.67	0.71	0.39
7	70	COMMON CARP	38.4	0.8	4.8	1.52	0.60	0.42
8	70	CHANNEL CATFISH	42.2	1.0	6.7	1.21	0.98	0.59
9	71	BLACK CRAPPIE	25.9	0.4	7.7	0.24	0.46	0.07
10	71	BLACK CRAPPIE	25.4	0.4	7.1	0.22	0.45	0.06
11	71	Q/A RE-ANALYSIS	-	-	7.7	0.27	0.35	0.09
12	71	COMMON CARP	32.8	0.6	2.3	0.62	0.21	0.04
13	71	COMMON CARP	30.2	0.6	2.6	0.14	0.11	0.02
14	71	CHANNEL CATFISH	39.6	1.1	7.7	0.41	0.59	0.21
15	71	CHANNEL CATFISH	36.1	1.0	8.3	0.72	0.91	0.39
16	72	BLACK CRAPPIE	27.9	0.4	6.3	0.39	0.33	0.01
17	72	COMMON CARP	29.5	0.5	2.8	0.18	0.10	0.00
18	72	COMMON CARP	30.5	0.5	2.9	0.25	0.20	0.00
19	72	SACRAMENTO BLACKFISH	29.0	0.4	12.4	0.20	0.11	0.00
20	73	COMMON CARP	34.8	0.5	1.1	0.07	0.00	0.00
21	73	CHANNEL CATFISH	26.4	0.1	2.4	0.13	0.07	0.00
22	73	CHANNEL CATFISH	32.3	0.3	3.1	0.22	0.14	0.00
23	73	WHITE CATFISH	30.5	0.3	1.3	0.35	0.00	0.00
24	77	SACRAMENTO BLACKFISH	31.2	0.4	8.5	0.20	0.06	0.00
25	77	IAG RE-ANALYSIS	-	-	8.5	0.20	0.06	0.00
26	77	SACRAMENTO BLACKFISH	27.9	0.3	6.5	0.16	0.04	0.00
27	77	STRIPED BASS	33.0	0.4	7.0	0.16	0.06	0.00
28	79	BLACK BULLHEAD	-	-	2.2	0.10	0.04	0.01
29	79	Q/A RE-ANALYSIS	-	-	2.3	0.11	0.03	0.00
30	79	Q/A RE-ANALYSIS	-	-	2.6	0.13	0.00	0.00
31	79	BLACK BULLHEAD	-	-	1.6	0.09	0.02	0.00
32	79	GREEN SUNFISH	-	-	5.1	0.09	0.02	0.00

Figure II-2

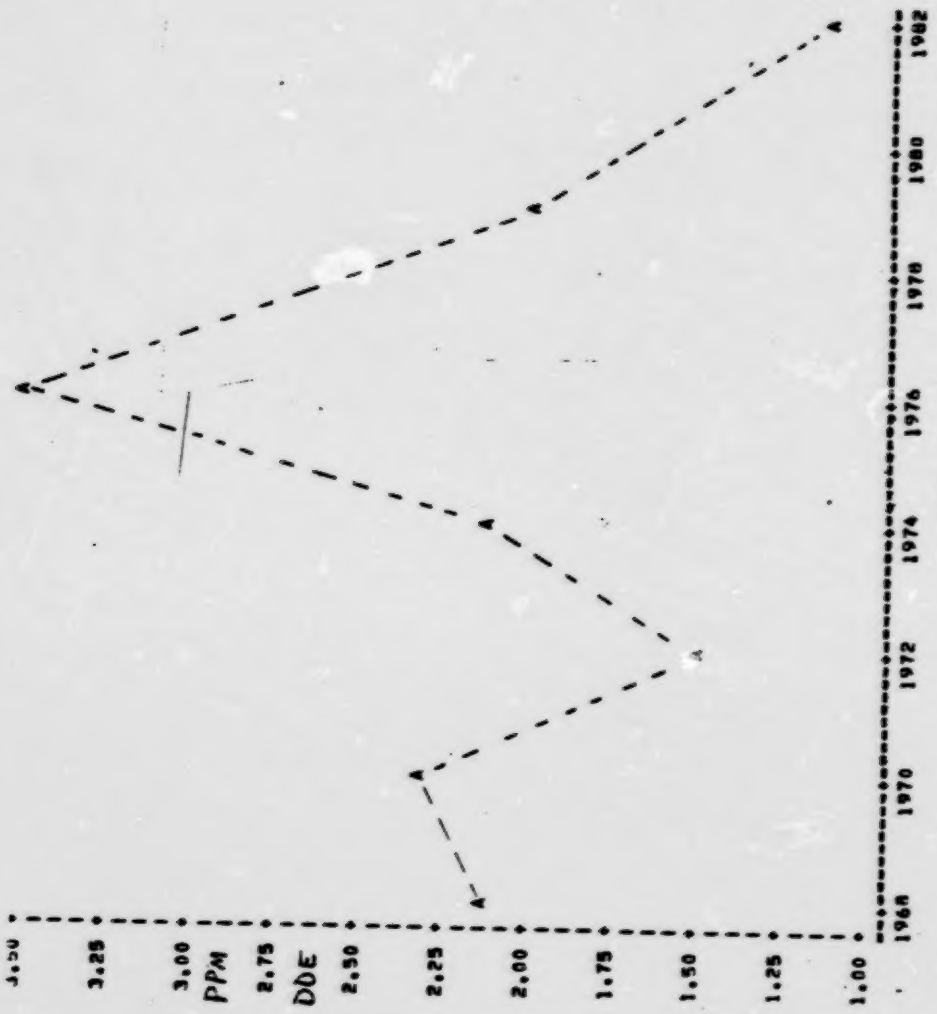

Figure 2. Mean DDE residues in starlings in the 4 'high residue' counties in California 1968-1982 (Kern, Ventura, Imperial, Monterey). Data 1968-1979 from published NPMP surveys, 1982 results from Bunck (pers. comm.).

have indicated a decline in DDE in fish. Residues at these stations in 1969 and 1970 were approximately in the 1-2 ppm (wet weight-whole fish) range and by 1979 had declined to 0.1 - 0.2 ppm DDE.

Fish pesticide-residue surveys by the state of California (Figure II-3) were more extensive than NPMP monitoring in the period 1976-1983. Though residues have fluctuated from year to year, state monitoring stations in San Joaquin Valley and the Imperial Valley have repeatedly shown residues that approach or exceed NAS ecological-hazard levels (1 ppm DDTr). Dicofol use in these counties is shown in Table II-13. Concerning these areas, the California State Water Resources Control Board (1981) noted that:

"Catfish from both the San Joaquin and Alamo rivers again exceeded the NAS recommended guideline for total DDT concentrations. Catfish from the New River contained total DDT residues that essentially equalled this guideline. Levels of DDT and its derivatives in fish from these three rivers have exceeded the NAS recommended guidelines of 1.0 ug/g (fresh weight basis) during all five years."

Fish fillet residue data for these areas were compiled for the period 1976-1983 from published state reports (California State Water Resources Control Board, 1979a; 1979b; 1979c; 1981; 1982; 1983; and 1984). Results for San Joaquin Valley stations are shown in the Table II-14. DDTr trends were analyzed for catfish species by station by regression (Statistical Analysis System 1979; General Linear Model procedure). No significant declines were evident (Table II-15). A pooled data set for the three stations was also analyzed; regression analysis did not indicate a downward trend in DDTr residues (Table II-15), rather levels have remained relatively constant throughout the monitoring period (Figure II-4).

Fish residue data for station 37 (New River) and station 38 (Alamo River) are shown in Table II-16. Trend analysis (regression) for these sites does not show residue dissipation. Regression of the channel catfish residue data on sampling year for the Alamo River indicates a significant increase. Highest values for Alamo River channel catfish and carp, in the 1976-1983 period, were recorded in the most recent survey (1983). Available use data (Table II-13) indicate significant increases in dicofol use in this region (Imperial County) in recent years (1981-1983). No other significant regression trends were demonstrated (Table II-17). Regarding the DDTr contamination at these stations California state researchers stated that:

"The Alamo and New rivers are the two major sources of freshwater for the Salton Sea. Because concentrations of DDT and its metabolites in fish from both the Alamo and New rivers remain elevated, often near or above the level known to produce shell thinning of bird's eggs, there is special concern about the adverse effects on nesting colonies of fish-

Figure II-3 **California pesticide monitoring network sampling stations (after California State Water Resources Control Board 1983, p.6).**

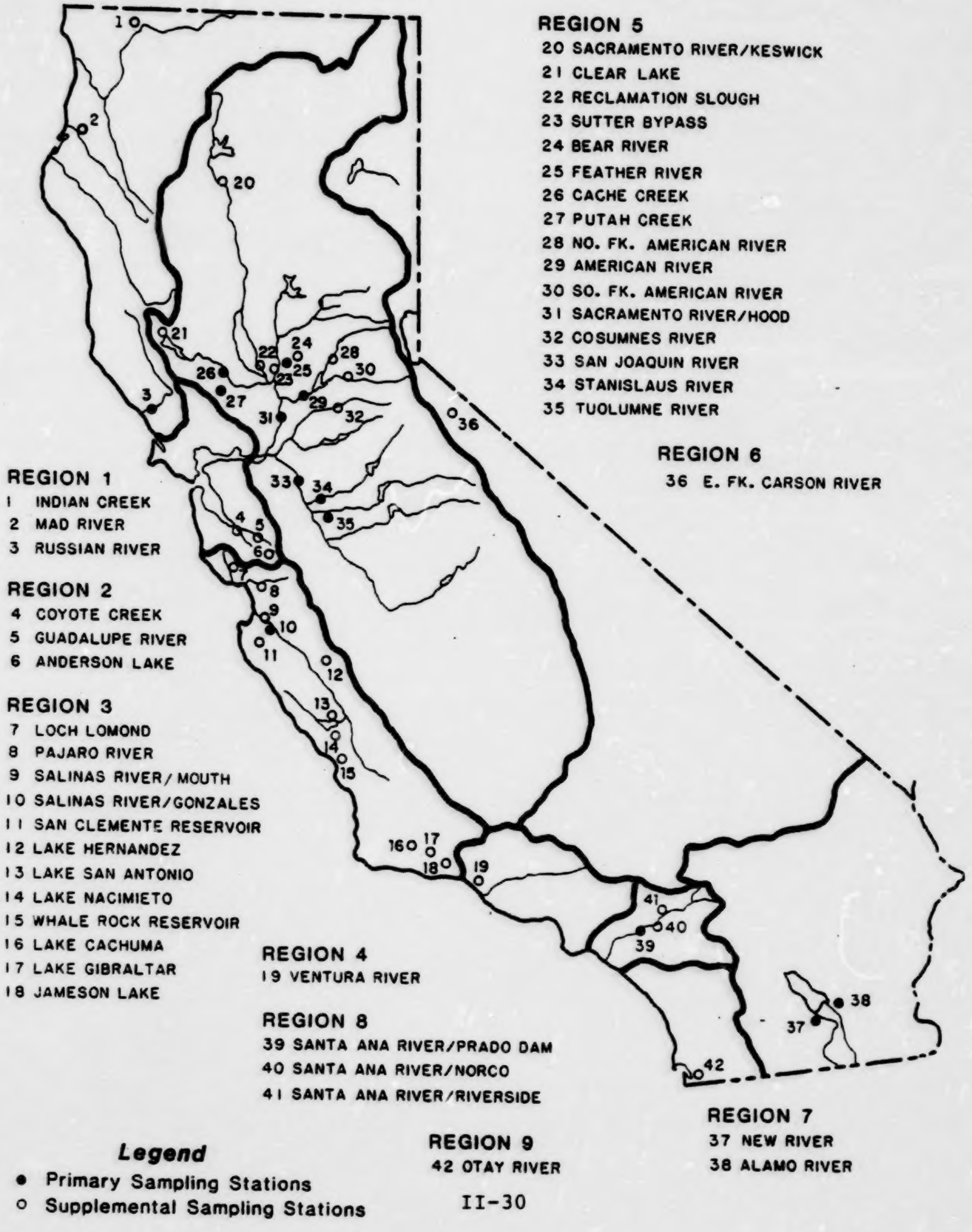
REGION 1
1 INDIAN CREEK
2 MAD RIVER
3 RUSSIAN RIVER
REGION 2
4 COYOTE CREEK
5 GUADALUPE RIVER
6 ANDERSON LAKE
REGION 3
7 LOCH LOMOND
8 PAJARO RIVER
9 SALINAS RIVER/MOUTH
10 SALINAS RIVER/GONZALES
11 SAN CLEMENTE RESERVOIR
12 LAKE HERNANDEZ
13 LAKE SAN ANTONIO
14 LAKE NACIMIETO
15 WHALE ROCK RESERVOIR
16 LAKE CACHUMA
17 LAKE GIBRALTAR
18 JAMESON LAKE
REGION 4
19 VENTURA RIVER
REGION 5
20 SACRAMENTO RIVER/KESWICK
21 CLEAR LAKE
22 RECLAMATION SLOUGH
23 SUTTER BYPASS
24 BEAR RIVER
25 FEATHER RIVER
26 CACHE CREEK
27 PUTAH CREEK
28 NO. FK. AMERICAN RIVER
29 AMERICAN RIVER
30 SO. FK. AMERICAN RIVER
31 SACRAMENTO RIVER/HOOD
32 COSUMNES RIVER
33 SAN JOAQUIN RIVER
34 STANISLAUS RIVER
35 TUOLUMNE RIVER
REGION 6
36 E. FK. CARSON RIVER
REGION 7
37 NEW RIVER
38 ALAMO RIVER
REGION 8
39 SANTA ANA RIVER/PRADO DAM
40 SANTA ANA RIVER/NORCO
41 SANTA ANA RIVER/RIVERSIDE
REGION 9
42 OTAY RIVER
Legend
● Primary Sampling Stations
○ Supplemental Sampling Stations
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Figure II-4 DDTr residues (ppm wet weight) in fish fillets at San Joaquin Valley sampling stations 33, 34, 35 (California State Water Resources Control Board), 1976-1983. Data plotted are those shown in Table II-14. The arithmetic means were calculated for each year by pooling species for the three stations; means are shown by open circles (°) and are line-connected.

PLOT OF DDT*YEAR , LEGEND: A = 1 OBS, B = 2 OBS, ETC.

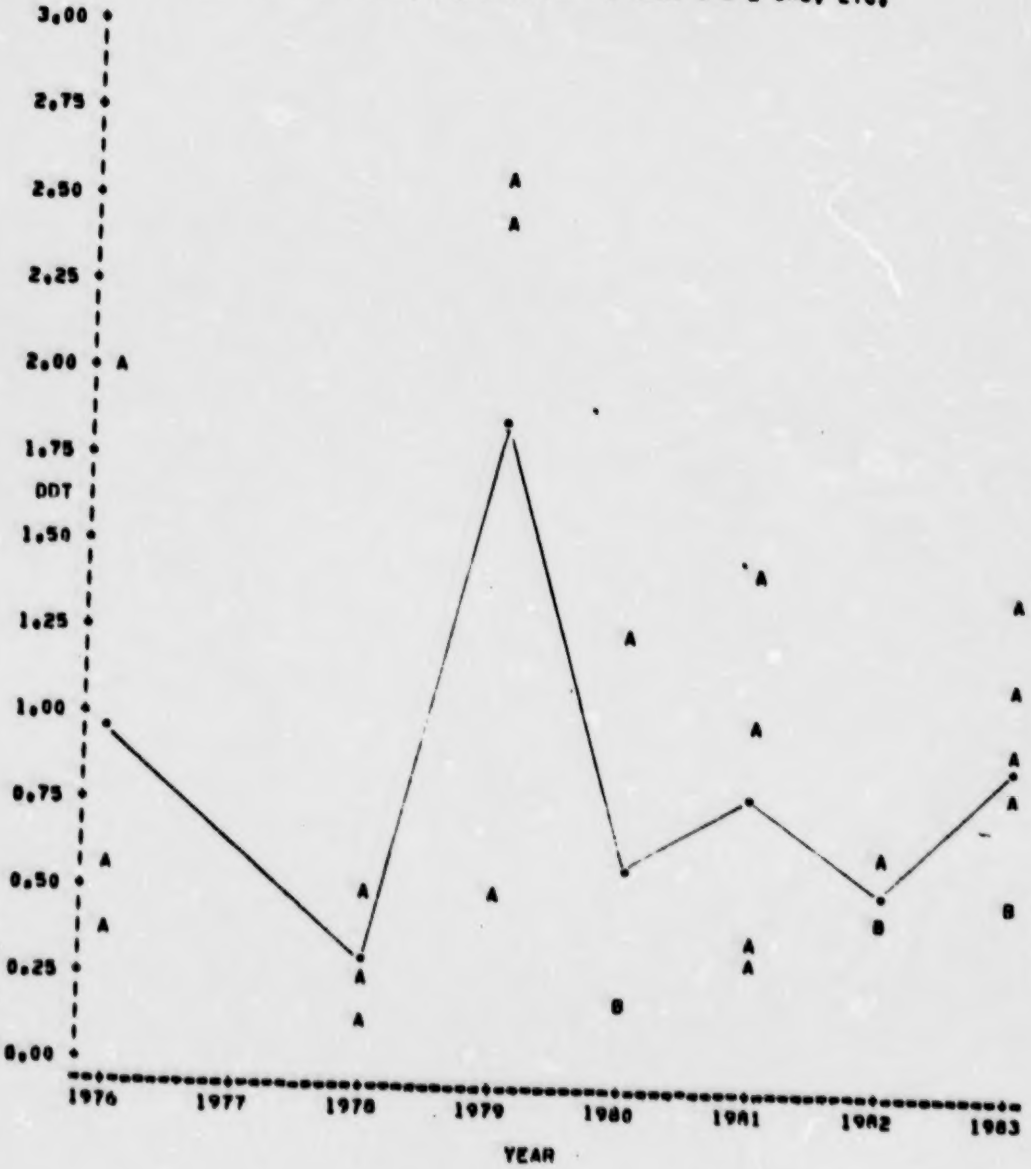


Table II-13 Dicofol use in San Joaquin, Stanislaus and Imperial Counties, California, 1970-1983 (California State Department of Food and Agriculture, Pesticide Use Reporting System, pers. comm. Susan Reaney).

	Pounds Active Ingredient		
	Imperial	San Joaquin	Stanislaus
1970	7162	-	24823
1971	5087	4082	7833
1972	3862	38514	990
1973	6946	40512	28723
1974	1475	43490	37259
1975	6844	41429	25164
1976	7492	57082	163778
1977	4036	58375	36386
1978	5541	20240	26962
1979	5202	15574	36356
1980	6936	7095	22506
1981	22302	13786	18501
1982	46361	27095	37730
1983	23835	43636	25522

Table II-14 DDTr residues in fish fillets at three San Joaquin Valley monitoring stations, 1976-1983. (California State Water Resources Control Board)

Obs	Year	River	Species	DDTr
1	1976	SJ	WC	1.980
2	1976	SJ	C	1.500
3	1976	ST	WC	0.360
4	1976	ST	C	0.860
5	1976	TU	WC	0.550
6	1976	TU	C	0.720
7	1978	SJ	WC	0.500
8	1978	SJ	C	1.268
9	1978	ST	WC	0.131
10	1978	ST	C	0.094
11	1978	TU	CC	0.267
12	1978	TU	C	0.059
13	1979	SJ	CC	2.420
14	1979	ST	CC	0.505
15	1979	TU	CC	2.570
16	1980	SJ	WC	1.230
17	1980	ST	WC	0.169
18	1980	TU	WC	0.213
19	1981	SJ	CC	1.417
20	1981	SJ	CC	0.983
21	1981	ST	CC	0.369
22	1981	TU	CC	0.301
23	1982	SJ	CC	0.611
24	1982	SJ	C	0.440
25	1982	ST	CC	0.443
26	1982	TU	CC	0.459
27	1983	SJ	CC	1.379
28	1983	SJ	WC	1.094
29	1983	ST	CC	0.479
30	1983	ST	WC	0.472
31	1983	TU	CC	0.935
32	1983	TU	WC	0.824

SJ = San Joaquin
ST = Stanislaus
TU = Tuolumne

C = Carp
CC = Channel catfish
WC = White catfish

Table II-15 Results of regression analyses of DDTR-residue trends in catfish species at 3 San Joaquin Valley sampling stations 1976-1983.

Station	River	Species	F	P>F	R^2
33	San Joaquin	WC	0.32	0.63	0.14
		CC	2.98	0.18	0.5
		WC + CC	2.13	0.18	0.18
34	Stanislaus	WC	0.36	0.61	0.15
		CC	0.08	0.81	0.04
		WC + CC	0.01	0.93	0.001
35	Tuolumne	WC	0.16	0.76	0.14
		CC	0.16	0.72	0.05
		WC + CC	0.03	0.88	0.003
Pooled stations and species			0.22	0.64	0.007

WC= White catfish
CC= Channel catfish

Table II-16 DDT homologs in fish collected in routine sampling (California State Water Resources Control Board) 1976-77 to 1983, Alamo and New Rivers.

	Alamo River		New River	
	sp	ppm*	sp	ppm*
1976/77	cp	3.11	bmb	1.455
			t	0.692
1978	cc	0.882	cc	3.368
	cp	1.490	cp	0.124
1979	cc	3.37	cc	2.2
			cp	1.423
1980	cc	2.482	cc	0.978
			cc	1.609
			cc	2.231
1981	cc	3.582	cc	0.852
	cp	4.621	cp	0.64
1982	cc	3.248	cc	2.739
	cp	2.060	cc	1.723
			cp	0.461
1983	cc	5.3	cc	2.794
	cp	9.098	cp	0.182

* = total DDT (DDT + DDD + DDE + DDMU + DDMS) in fish fillets
cp = carp
cc = channel catfish
bmb = big mouth buffalo
t = tilapia

Table II-17 Results of regression analyses of DDTR trends for channel catfish and carp at station 37 (New River) and station 38 (Alamo River) 1976-1983.

Station	Species	F	P>F	R^2
37	Channel Catfish	0.07	0.8	0.01
	Carp	0.28	0.64	0.08
38	Channel Catfish	9.87	0.035	0.71
	Carp	1.52	0.31	0.34

eating birds around the Salton Sea" (California State Water Resources Control Board, 1981).

The Alamo and New Rivers flow from Mexico into the U.S. As DDT is still legally used in Mexico (Schmitt et. al. 1983), it is reasonable to question how much DDT applications in Mexico contribute to the DDTr fish residues observed at near-border sites such as those on the Alamo and New Rivers. Insufficient data are available to fully answer this question. However, the fish-residue analyses have been reported on an isomer-basis, thus we may test the hypothesis that stations receiving drainage from Mexico have higher proportions of p,p-DDT (indicating recent exposure to the parent compound) than stations which receive no Mexican drainage and are roughly 400 miles north of the border. Channel catfish were selected for this analysis as they comprised approximately one half of all samples reported and occurred at all five stations. Percentage p,p'-DDT of total-DDT was calculated for each sample (Table II-18) and percentages were arc sin transformed. Data were analyzed by two-way ANOVA; stations and years were examined as sources of variance.

Results (Table II-19) showed that percentage p,p'-DDT did not vary over time ($P > F = 0.23$) but did vary between stations ($P > F = 0.026$). Stations near the Mexican border had lower concentrations of p,p'-DDT (New River, station 37, $\bar{x} = 4.1$ percent; Alamo River, station 38, $\bar{x} = 5.5$ percent) than central valley stations (San Joaquin River, station 33, $\bar{x} = 11.9$ percent; Stanislaus River, station 34, $\bar{x} = 11.8$ percent; Tuolumne River, station 35, $\bar{x} = 8.5$ percent). Christopher Schmitt (1984) reports that NPMP fish-residue surveys indicate a national average for p,p'-DDT at roughly ten percent of total-DDT over the period 1976 to 1981. From these data we conclude that the p,p'-DDT concentration in California fish at San Joaquin and Imperial Valley stations conform to national trends and that even stations receiving drainage from Mexico do not indicate significant exposure from recent DDT applications. This suggests that the apparent stabilization of DDTr residues at these stations is the result of the extreme persistence of DDTr or ecosystem loading of DDTr from sources low in p,p'-DDT (e.g. dicofol).

b. Sensitive Wildlife in California

Peregrine falcons once occurred widely in North America but are now rare or absent in much of their former range and have been designated as endangered species by the Fish and Wildlife Service. Though many factors may have contributed to their decline the most significant cause of population reduction was their exposure to DDE (U.S. Department of Interior, 1982a). DDE thinned peregrine eggshells such that egg breakage occurred. DDE may have also resulted in less well understood behavioral changes such as egg eating, failure to attempt nesting, reduced nest attentiveness. Though legal use of DDT stopped in 1972, recent studies have shown that DDE

Table II-18 Analysis of p,p-DDT as a percentage of total DDT (DDT + DDD + DDE + DDMU +DDMS) in channel catfish (Ictalurus punctatus) (California State Water Resources Control Board 1976 - 1983).

		River						
	Station	San Joaquin #33	Stanislaus #34	Tuolumne #35	Alamo #38	New #37		
	Total DDT							
1976-77	p,p-DDT		--------- NO CHANNEL CATFISH COLLECTED -----------					
	% p,p-DDT							
	Total DDT	-	-	0.267	0.882	3.368		
1978	p,p-DDT			0.028	0.066	0.159		
	% p,p-DDT			10.5	7.5	4.7		
	Total DDT	2.420	0.505	2.57	3.370	1.423	2.200	
1979	p,p-DDT	0.3	>0.01	0.2	0.16	0.073	0.1	
	% p,p-DDT	12.4	>2.0	7.8	4.7	5.1	4.5	
	Total DDT	-	-	-	2.482	2.231	1.609	0.978
1980	p,p-DDT				0.140	0.13	0.18	0.15
	% p,p-DDT				5.6	5.8	11.2	15.3

Table II-18, continued

		River						
	Station	San Joaquin #33		Stanislaus #34	Tuolumne #35	Alamo #38	New #37	
1981	Total DDT	1.417	0.982	0.369	0.301	3.582	0.852	
	p,p-DDT	0.16	0.046	0.03	0.012	0.063	0.015	
	% p,p-DDT	11.3	4.7	8.1	4.0	1.8	1.8	
1982	Total DDT	0.611		0.443	0.459	3.248	1.723	2.739
	p,p-DDT	0.083		0.08	0.039	0.094	0.035	0.045
	% p,p-DDT	13.6		18.1	8.5	2.9	2.0	1.6
1983	Total DDT	1.379		0.479	0.935	5.300	2.794	
	p,p-DDT	0.240		0.043	0.110	0.121	0.081	
	% p,p-DDT	17.4		9.0	11.8	2.3	2.9	

Table II-19 Analysis of variance of percent p,p' DDT in channel catfish at San Joaquin and Imperial Valley monitoring stations (see Table II-18).

```
DEPENDENT VARIABLE: p,p' DDT

SOURCE                  DF        SUM OF SQUARES        MEAN SQUARE     F VALUE

MODEL                   23            0.05864255         0.00254968        1.87

ERROR                    5            0.00681323         0.00136265      PH > F

CORRECTED TOTAL         28            0.06545578                         0.2520

R-SQUARE               C.V.             ROOT MSE        p,p' DDT MEAN

0.895911            49.2453           0.03691403           0.07495950

SOURCE                  DF           TYPE I SS   F VALUE     PR > F

YEAR                     5          0.00548883      0.81     0.5909
RIVER                    4          0.04095753      7.51     0.0241
YEAR*RIVER              14          0.01219619      0.64     0.7664

SOURCE                  DF           TYPE I SS   F VALUE     PR > F

YEAR                     5          0.01368727      2.01     0.2311
RIVER                    4          0.03959420      7.26     0.0259
YEAR*RIVER              14          0.01219619      0.64     0.7664
```

persists in prey items (i.e. smaller birds: Table II-20) in California at levels "sufficiently high to be potentially deleterious to the reproduction of peregrines" (Risebrough et al., unpubl). Moreover, DDE is still high in many eggs (Table II-21) and shell thinning continues to be a problem. Migrant species that pick up DDE outside the United States are likely to be a significant source of DDE to those peregrines that eat them, but the "comparatively high residues in local populations of starlings and killdeers suggest that sufficient DDE still remains in some areas of California to constitute a potential hazard to peregrines" (Monk et al., unpubl).

Eggshell thinning in California condors, also an endangered species, has not been clearly correlated with reproductive failure and "that DDT contamination might have been a major factor in the recent decline of the species is not obvious from the nest success and egg breakage data" (Synder, 1983). The California condor, however, is near extinction with a current population estimated at fewer than 50 birds (Kiff et al., 1979) and recent studies suggest that DDE may be a more important factor in the decline of this species than formerly thought. Low egg production has precluded collection of whole eggs for residue analysis but pesticide extraction from shell membranes has shown DDE in most samples; moreover, significant shell thinning was documented for pesticide-era eggs (>1943) and degree of thinning was highly correlated ($r= -.93$, $P < 0.1$) with estimated DDE residues. Eggs of three pairs of condors are currently being monitored: one pair is producing eggshells 25-27 percent thinned, a second pair is showing approximately ten percent thinning and a third pair is producing eggshells of normal thickness (Synder, 1984.)

The Office of Endangered Species' recovery plan for the condor (U.S. Department of Interior, 1979b) lists condor habitation of eight counties (Fresno, Tulare, Kern, Ventura, Los Angeles, Monterey, San Luis Obispo and Santa Barbara). The Agency estimated total annual dicofol use in these counties at 317,000 pounds (technical) (Figures II-5 and II-6). This suggests over (over 30,000 pounds DDTr) added to the environs of this species each year.

The Pacific population of bald eagles has declined as have bald eagle populations in most other areas of the United States. DDT has been related to reproductive failure (by shell thinning) and direct mortality of adult eagles. Though eagle reproduction is believed to have improved since the ban on DDT, "organochlorines (primarily DDE) are still present in significant levels in some pairs in Oregon" and "Twenty percent of northwestern eagles examined at Patuxent Wildlife Research Center (USDI, Fish and Wildlife Service) recently contained DDT levels high enough to hinder reproduction" (U.S. Department of the Interior, 1982). Thelander (1984) reports that bald eagle reproduction has not

Table II-20 DDE Concentrations in prey species of California peregrine falcons, 1980. (Parts per billion of the wet weight, nanograms/gram.) (Monk et al. unpubl.)

Species	Collection Area	N	Arithmetic Mean	Standard Deviation	Geometric Mean	Range of Std. Dev.
Killdeer	2b	3	5000	6300	2000	300-14000
	3	2	47	11	46	37-58
	5	5	900	900	550	170-1700
	7	9	4400	7100	970	95-9800
Short-billed Dowitcher	7	10	250	210	180	72-450
Western Sandpiper	2a	15	290	400	140	41-500
	7	10	400	420	210	60-770
Sanderling	7	10	1000	1300	670	280-1600
Red Phalarope	4b	3	630	320	580	360-940
Band-tailed Pigeon	3	3	0.31	0.04	0.31	0.15-29
Rock Dove	8	3	48	33	42	22-78
Mourning Dove	3	3	65	34	57	29-112
	7	3	26	41	6	0.74-59
	8	3	44	31	32	11-97
Acorn Woodpecker	3	4	2.0	1.2	1.7	0.9-3.3
	4	4	10	7.1	8.6	4.4-16
	6	10	7	5.8	5.9	3.4-10
	7	5	17	8.7	15	8.4-27
	8	5	11	6.4	10	6.1-17
Violet-green Swallow	2b	4	380	290	290	120-690
	3	1	1600	-	-	-
	4	1	1200	-	-	-
	6	10	2400	1900	1800	790-4000

Table II-20 (continued)

Species	Collection Area	N	Arithmetic Mean	Standard Deviation	Geometric Mean	Range of Std. Dev.
Violet-green Swallow (continued)	7	5	3100	2200	2000	1600-2400
	8	5	5800	1300	5700	5400-7200
Steller's Jay	3	3	3.3	0.58	3.3	2.8-3.9
	6	3	76	76	55	21-143
	8	3	42	7.2	42	35-49
Robin	1	3	370	420	210	57-800
	3	3	490	680	210	39-1100
	4	3	880	1400	270	41-1800
Western Bluebird	3	3	29	11	28	19-41
Starling	2	3	91	59	81	45-146
	4	3	2100	546	2100	1600-2700
	7	3	73	30	69	43-109
Western Meadowlark	3	3	78	48	64	28-147
	7	3	43	38	33	12-95
	8	3	73	30	67	43-109
Black-headed Grosbeak	6	5	77	52	61	28-135
	7	5	54	43	42	21-85

Table II-21 DDE and PCB in eggs of California peregrine falcons, 1980-1981. Eggs unhatched in the wild or which did not successfully hatch during artificial incubation. Parts per million of the fresh weight as received. (Risebrough et al., unpubl.)

Geographic Area	Site*	Year	DDE	PCB	% H_2O	% lipid of dry	Comments
North Interior	NI-13	1980	29	12	86	25	From first clutch. Died approximately one week before hatching; third egg hatched.
North Interior	NI-13	1980	21	16	63	23	Same clutch as above; died approximately 2-4 days before expected hatching.
North Interior	NI-21	1980	30	8	61	21	From first clutch. Died approximately two weeks before expected hatching; other eggs hatched.
North Interior	NI-21	1980	42	18	65	28	From second clutch; no development, dehydrated; all eggs died.
North Interior	NI-21	1980	16	8	81	31	Same clutch as above; 1/4 inch embryo.
North Interior	NI-16	1981	19	9	81	**	From first clutch which went full term in the eyrie. Two eggs hatched. No development of this egg.
North Interior	NI-17	1981	41	12	75	**	From first clutch of two eggs; one hatched. Development of this egg - 1/16 inch embryo.

Table II-21 (continued)

Geographic Area	Site*	Year	DDE	PCB	% H_2O	% lipid of dry	Comments
North Interior	NI-18	1981	2	0.41	77	**	From first clutch which went full term in the eyrie. Two chicks hatched. This egg 1/16 inch embryo.
North Interior	NI-21	1981	31	10	78	**	From first clutch of two eggs. None hatched. This egg was undeveloped.
North Interior	NI-25	1981	7	2	82	**	From second clutch of three eggs; two hatched. First clutch of eggs all broken by attending parent.
Mid Coast	MC-2	1980	24	6	84	21	Second clutch;all eggs of first clutch broken at eyrie; one egg hatched; this egg 1/4 inch embryo.
Mid Coast	MI-2	1980	32	5	80	31	Same clutch as above, no development.
Mid Coast	MC-3	1980	14	4	81	30	First clutch; two other eggs hatched; 1/4 inch embryo.
Mid Coast	MC-4	1980	18	13	81	36	No development. From second clutch; second egg hatched. First clutch all hatched.

Table II-21 (continued)

Geographic Area	Site*	Year	DDE	PCB	% H_2O	% lipid of dry	Comments
Mid Coast	MC-2	1981	19	15	79	**	From second clutch containing five eggs; only two hatched. In first clutch two of three eggs hatched.
Mid Coast	MC-3	1981	27	11	80	**	From first clutch in which only one of three eggs hatched.
Mid Coast	MC-4	1981	26	14	78	**	From first clutch of four eggs. Three hatched successfully.
South Interior	SI-3	1980	15	5	81	30	Only egg in first clutch; 1/4 inch embryo.

* 1980 U.S. Fish and Wildlife Service designation numbers

** Data unavailable.

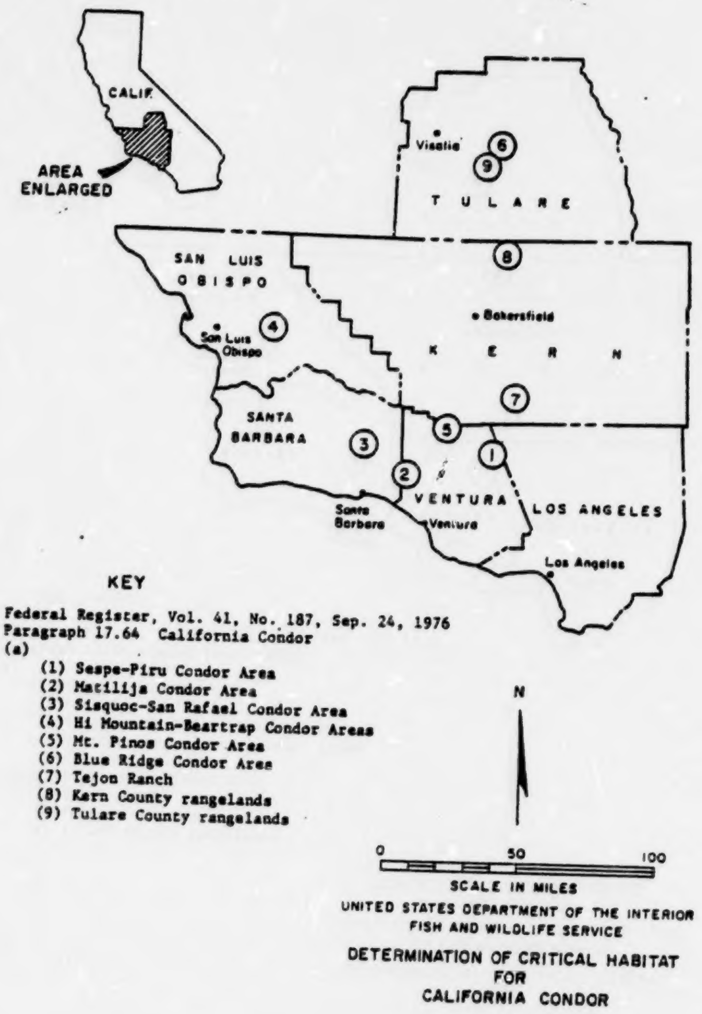
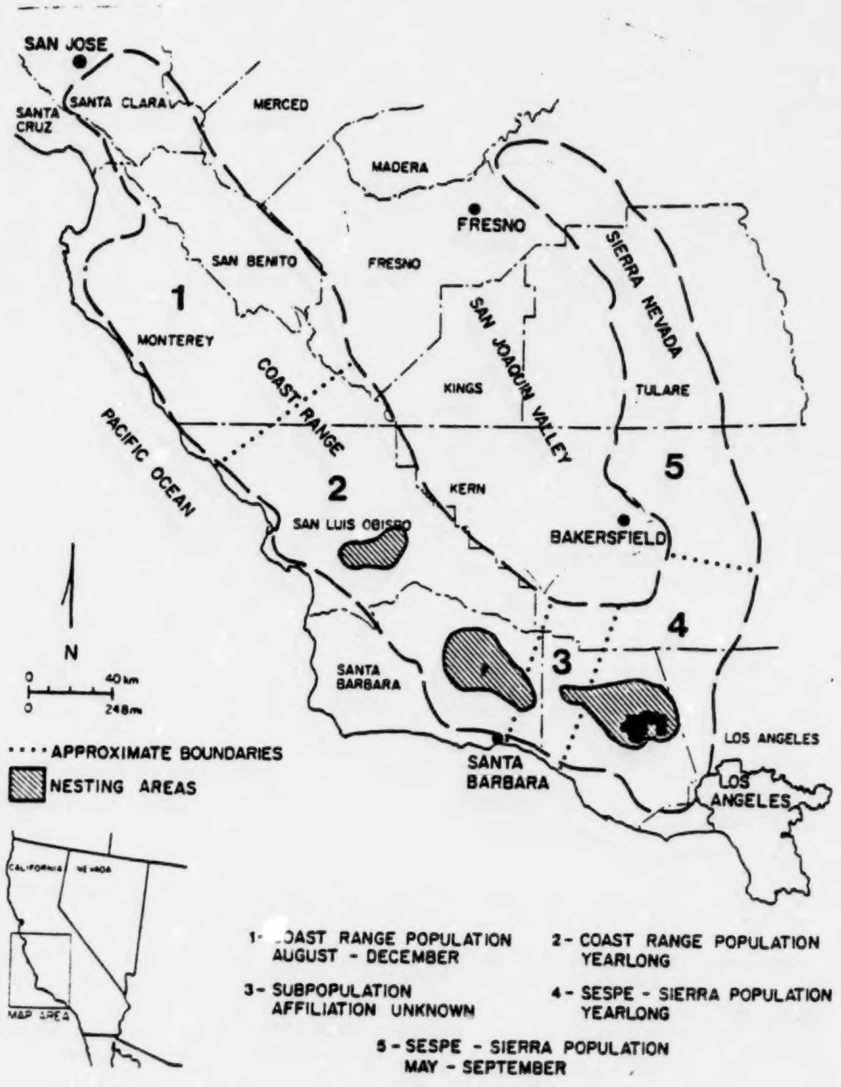

CALIF.
AREA ENLARGED
Visalia
TULARE
SAN LUIS OBISPO
San Luis Obispo
Bakersfield
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
Santa Barbara
Ventura
Los Angeles
1
2
3
4
5
6
7
8
9
KEY
Federal Register, Vol. 41, No. 187, Sep. 24, 1976
Paragraph 17.64 California Condor
(a)
(1) Sespe-Piru Condor Area
(2) Matilija Condor Area
(3) Sisquoc-San Rafael Condor Area
(4) Hi Mountain-Beartrap Condor Areas
(5) Mt. Pinos Condor Area
(6) Blue Ridge Condor Area
(7) Tejon Ranch
(8) Kern County rangelands
(9) Tulare County rangelands
N
0
50
100
SCALE IN MILES
UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
DETERMINATION OF CRITICAL HABITAT
FOR
CALIFORNIA CONDOR

Figure II-5
DICOFOL USE

1981/82 (lbs a.i.)

Kings County....	215,800
Kern County.....	156,100
Tulare County...	113,200
Ventura County..	34,400

Figure II-6 Geographic range of the California Condor (U.S. Department of the Interior, 1979b)


SAN JOSE
SANTA CLARA
SANTA CRUZ
MERCED
MADERA
FRESNO
SAN BENITO
FRESNO
SIERRA NEVADA
1
MONTEREY
SAN JOAQUIN VALLEY
COAST RANGE
KINGS
TULARE
PACIFIC OCEAN
5
2
KERN
SAN LUIS OBISPO
BAKERSFIELD
4
N
0 40 km
0 24 Bm
3
SANTA BARBARA
LOS ANGELES
APPROXIMATE BOUNDARIES
NESTING AREAS
SANTA BARBARA
LOS ANGELES
CALIFORNIA
NEVADA
MAP AREA
1- COAST RANGE POPULATION AUGUST - DECEMBER
2- COAST RANGE POPULATION YEARLONG
3- SUBPOPULATION AFFILIATION UNKNOWN
4- SESPE - SIERRA POPULATION YEARLONG
5- SESPE - SIERRA POPULATION MAY - SEPTEMBER

been studied thoroughly in California; his recent investigations (with Kiff and Risebrough) indicate significant eggshell thinning persists and DDE in eggs may reach critical levels. The four eggs collected in 1983 had greater than 15 percent shell thinning and one contained over 1100 ppm DDE (wet weight), one of the highest residue levels ever recorded in a bird egg (Thelander, 1984). California bald eagles primarily breed in northern parts of the state but wander widely during other periods, including southern and central California where prey items such as fish and ducks are still carrying potentially hazardous levels of DDE in some areas (see previous section on environmental residues).

The U.S. Fish and Wildlife Service has begun studies of black-crowned night herons nesting on San Francisco bay (Olhendorf, 1984). Preliminary results show some collected eggs contain DDE residues (wet weight basis) of 15 ppm which exceed levels (8 ppm) shown to cause effects in previous studies with this species. Bird-banding recovery data indicate that a portion of this population winters in the San Joaquin and Salinas Valleys of central California where they may be exposed to dicofol application.

2. Arizona

The Agency estimates that dicofol use in Arizona (1981/82) totalled 126,000 pounds of active ingredient. These applications were essentially on two crops (cotton - 94,500 pounds and citrus - 31,700 pounds) and were concentrated in three counties (Maricopa - 70,100; Pinal - 25,600; and Yuma 18,400 pounds). A survey of pesticide use in Arizona by the University of Arizona (Byrne and Roll, unpubl.) indicates increasing dicofol use in recent years:

1978	1979	1980	1981
18,100	11,000	54,800	106,900

(Dicofol Pounds Active Ingredient)

a. Environmental Residues

Pesticide residue surveys indicate that fish and wildlife in Arizona are carrying potentially hazardous levels of DDE (Clark and Krynitisk, 1983; Arizona Department of Health Services, 1984). Starlings have been monitored at four sites in the state in NPMP surveys; the station in Maricopa County, the major agricultural county in the state, has consistently shown residues among the highest measured in the U.S. (Table II-22). Ducks are more migratory than starlings and perhaps not as good an indicator of local contamination; however, results of the 1979-80 NPMP duck wing survey show the Arizona/Western New Mexico sampling area with the highest mean DDE residue in the nation (1.22 ppm) (Clark and Krynitsky, 1983). In a separate study (Fleming and

Table II-22 National Pesticide Monitoring Survey starling residues at station 4-C-1, Maricopa County, Arizona.

Year	Carcass DDE (PPM)	Rank Nationally
1974[1]	9.11	1
1976[2]	5.00	5
1979[3]	6.44	2
1984[4]	8.4	1

[1] White, 1976

[2] White, 1979b

[3] Cain and Bunck, 1983

[4] Bunck, 1984

Cain, in prep.), duck wing residue data from the 1979-80 hunting season were more finely divided geographically in Arizona. These data show high residues from the eastern Gila and Verde river areas (1.36 to 5.95 ppm DDE). Most of these samples were from Maricopa County suggesting the possible influence of the high local dicofol use.

Monitoring of fish tissue in Arizona has similarly shown high residues, again particularly in Maricopa County (Gila River drainage). In Painted Rock Reservoir in 1980 Clark and Krynitsky (1983) reported residues (DDE) in channel catfish of 9.56 ppm, 6.86 ppm in carp, 7.53 ppm in largemouth bass and 0.65 ppm in tilapia. In the Gila river, also for 1980, they report carp with 6.8 and 5.78 ppm DDE. DDE residues continue at these high levels in 1983 with Arizona Game and Fish Department (Dahlberg, 1984) reporting the following information:

Species	PPM DDE	Location
Carp	7.9	Arlington Canal, Maricopa County
Catfish	5.0	" "
Carp	1.4	Buckeye Canal, Maricopa County
Carp	5.3	" "
Goldfish	3.4	Gila River, Maricopa County

Though high residues have been concentrated in the Maricopa County area recent samples (≥ 1980) from southwestern Arizona (Yuma) have also had DDE residues exceeding NAS (1 ppm) and FDA (5 ppm) hazard criteria (Arizona Department of Health Services 1984). NPMP monitoring of fish from station 115 (Colorado River at Yuma) likewise support concern for elevated residues in this area of the state though Schmitt et al. (1983) attributed the contamination to use of DDT in Mexico:

Year	Species	DDT (PPM)*	DDE
1976	Carp	0.03	0.03
1976	Largemouth bass	1.27	0.74
1976	Striped mullet	2.9	1.3
1978	Carp	0.57	0.43
1978	Largemouth bass	1.19	0.83
1978	Striped Mullet	2.91	1.35

*(U.S. Fish and Wildlife Service [NPMP] unpubl.)

b. Sensitive Wildlife in Arizona

Peregrine falcons in Arizona as elsewhere in the U.S. are endangered. Monitoring in recent years in Arizona indicates that productivity is normal among many of the pairs studied (Ellis 1984). Nonetheless, some pairs studied recently nested unsuccessfully and DDE has been found in unhatchted eggs (1978-1982) at levels potentially deleterious to reproduction:

Year	PPM DDE (wet weight except as noted)
1978	33 (dry weight)
1981	14
1982	14
1982	10
1982	6.4
	(D. Ellis, 1984)

Peakall (1975) reviewing pesticide residue and reproductive data for the peregrine concluded that a critical level causing hatching failure was 15-20 ppm DDE (wet weight) in eggs. Though these values should be used cautiously they suggest that some Arizona peregrines are exposed to or continue carry DDE residues high enough to adversely affect reproduction.

The U.S. Fish and Wildlife Service has made recent (1981) collections of potential peregrine prey species in Arizona (Table II-23) to estimate DDE exposure. These collections were outside the principal citrus and cotton areas. Residues in pooled samples for several of the species were considerably above levels known to cause reproduction effects. Highest residues were observed in killdeer (8.78 ppm), red-winged blackbirds (5.55 ppm), cliff swallows (3.2-3.7 ppm), white-throated swifts (3.06 ppm) and Brewer's blackbird (1.42 ppm).

The southwestern bald eagle reaches its highest density (12-13 known breeding territories) in central Arizona (US Fish and Wildlife Service, 1982b). Though these breeding areas are northeast of the currently known high DDE-contamination area (Gila river, Painted Rock Reservoir; Clark and Krynitsky 1983) the eagles wander during non-breeding periods and both migratory northern bald eagles and local bald eagles feed on fish and other wildlife in the Gila drainage, Painted Rock reservoir and lower Colorado regions (Glintiski, 1984). Recent monitoring in these areas consistently shows fish residues in excess of 1 ppm DDE.

Little information is currently available on DDE in Arizona bald eagles; however, three eggs from two nests in 1977 had DDE ranging from 4.9 - 9.0 (wet weight). These three eggs had eggshell thickness of 0.513, 0.525 and 0.54 mm. No historical pre-DDT bald eagle records are available for Arizona so these thickness values were compared to data from southern California, Texas, and Florida. These compar-

Table II-23 DDE carcass residues in prey species of peregrine falcons in Arizona. Data supplied by James E. Johnson Albuquerque Office, U.S. Fish and Wildlife Service.

Species	Date[1]	Pool Weight (g)	PPM DDE
Killdeer (6)[2]	7/2/81	367.68	8.78
Mourning dove (10)	6/8/81	830.14	0.04
Mourning dove (11)	7/9/81	554.14	0.03
White-winged dove (5)	6/25/81	550.15	0.01
White-throated swift (11)	7/9/81	234.93	1.5
Ash-throated flycatcher (5)	6/4/81	102.12	0.06
Horned lark (9)	6/28/81	182.98	0.03
Cliff swallow (12)	6/3/81	162.43	3.20
Cliff swallow (12)	6/17/81	179.43	3.70
American robin (7)	7/10/81	416.63	0.21
Western meadowlark (9)	7/2/81	631.16	0.08
Western meadowlark (9)	6/16/81	737.67	0.59
Brewer's blackbird (7)	6/17/81	342.13	1.42
Brewer's blackbird (12)	7/10/81	537.69	0.47
Red-winged blackbird (5)	7/4/81	187.32	5.55
Hooded oriole (8)	6/29/81	148.38	0.26
Steller's jay (9)	7/10/81	720.80	0.05
White-throated swift (11)	6/30/81	233.11	3.06
Brown-head cowbird (4)	7/8/81	108.98	0.43
Brown-headed cowbird (8)	7/8/81	205.98	0.28

[1] Species collected over a stretch of dates were assigned a date midpoint between the earliest and latest collections.

[2] Number of birds in pool.

isons indicated thinning ranging from seven to 15 percent depending on the historical values used (Grubb and Rubink, 1978).

From a linear regression relationship of DDE-egg residues and production of young, Wiemeyer et al. (1984) projected that 3.5 ppm would result in 0.7 offspring per nest, the minimum considered necessary for population stability in bald eagles. Though it is not known how representative of regional norms the available Arizona egg residues data are or how applicable the critical offspring estimate (0.7/nest) is to the Arizona population, the available egg residue data exceed the 3.5 ppm critical limit suggesting a potential for DDE-impact on population stability.

With fish and bird species contaminated with DDE in parts of Arizona it is reasonable to assume that predatory birds sensitive to DDE that eat these food resources may be accumulating residues and showing effects. As elsewhere, however, such knowledge is restricted by the number of scientific investigations conducted. In Arizona only one indepth study of DDE effects on wildlife was located. Synder et. al. (1973) studied Cooper's hawks in Arizona and New Mexico in 1969-71. They found evidence of eggshell thinning, aberrant behavior and nest failure that was positively correlated with DDE residues in eggs and offspring. The researchers analyzed prey species of the Cooper's hawk for DDE; though strict comparisons are not possible, avian species taken had DDE residues not dissimilar from recent collections made of the peregrine food base (Table II-23). No recent follow-up work was done by the researchers nor is any known to them (Synder, 1984) but it is prudent to assume in the absence of new information that effects of DDE will not disappear until this contaminant dissipates from wildlife foodchains.

3. Texas

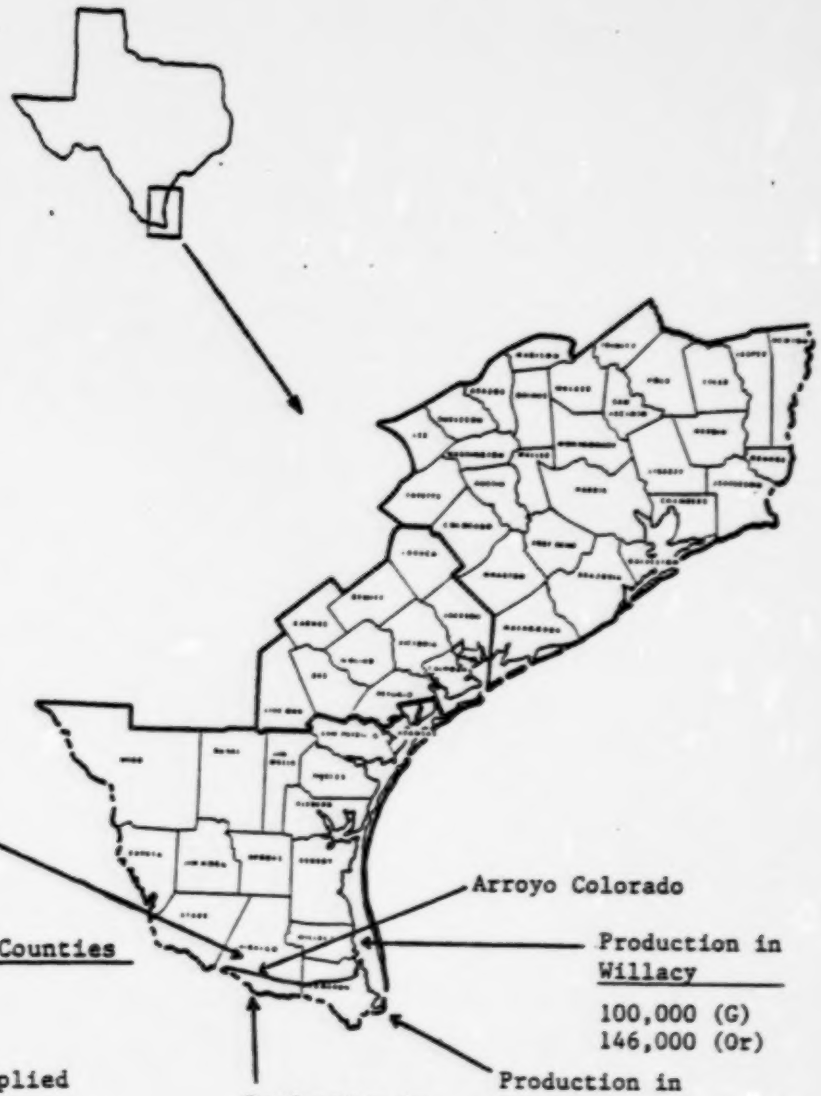
Dicofol use in Texas is largely confined to citrus according to Agency records. Citrus production is not widely dispersed in the state, but essentially occurs in Hidalgo, Willacy and Cameron counties at the southern tip of Texas (Figure II-7). Of these counties Hidalgo is the major production area accounting for roughly 80 percent of the state's citrus output and probably a similar proportion of the 153,900 pounds of dicofol used on Texas citrus.

a. Environmental Residues

Hidalgo county has been identified as an area of high DDE contamination (White et. al., 1983a):

"Over the years, DDE residues have been detected at fairly high levels in whole-fish composites from NPMP station No. 16 near Mission, Texas. Although DDE residues in fishes at this

TEXAS



1981
Citrus Production
State Total (boxes)

6,700,000 Grapefruit (G)
4,330,000 Oranges (Or)

Percent of State Total
in Hidalgo County

86% (G)
91% (Or)

Percent of State Total
in Hidalgo, Cameron & Willacy Counties

99.85% (G)
99.72% (Or)

Pounds (a.i.) of Pesticide Applied To Citrus in Texas (1977)

Dicofol	133,145
Chlorobenzilate	267,101

Arroyo Colorado

Production in Willacy

100,000 (G)
146,000 (Or)

Production in Hidalgo

5,740,000 (G)
3,940,000 (Or)

Production in Cameron

850,000 (G)
232,000 (Or)

Figure II-7 Citrus production in Texas in 1981 (Texas Crop and Livestock Reporting Service 1982). Pesticide use estimates are from Haydu (1981).

station have varied considerably among years, levels have not declined appreciably since the use of DDT was banned in 1972, as they have at most other monitoring stations across the nation (O'Shea and Ludke, 1979). A survey in 1976 of DDE levels in fishes from 12 sites along the main stem of the Rio Grande in Colorado, New Mexico, and Texas, and three sites in the lower Rio Grande Valley also indicated that residues varied among sites and among species. With few exceptions, residues appeared lower at these sites, overall, than those detected at NPMP station 16. These data are not entirely comparable since the same species of fishes were not available at each collecting site. However, the results do suggest that the major sources of contamination probably were centered in the lower Rio Grande Valley, especially in the Llano Grande Lake area, an impounded portion of the Arroyo Colorado."

The NPMP fish residue monitoring at station 16 (Table II-24) prompted more detailed investigation of fish in the Arroyo Colorado and also of fish-eating birds. In this special survey, elevated levels of DDE were detected in freshwater fish throughout this drainage area (Table II-25) and ranged to 31.5 ppm in channel catfish. Residues were lowest in the downstream, saltwater stretches of the Arroyo Colorado and highest in the Llano Grande Lake area which is an impounded portion of the river. Birds were collected at several locations in the lower Rio Grande Valley. Residues were high in all bird species sampled with laughing gulls showing the greatest DDE contamination. Median residues in this species were highest in the Llano Grande Lake area of the drainage (34 ppm) as in fish and lowest in birds taken in the Laguna Madre (2 ppm). The DDE residues in great-tailed grackles (14 ppm) and red-winged blackbirds (4.1 ppm) suggest that terrestrial foodchains are also contaminated.

Of the birds and fish that were sampled along the heavily farmed 60 mile stretch of river from McAllen to Port of Harlinger the researchers concluded:

"The potential impacts of DDE contamination to birds, especially fish-eating species, of the Arroyo Colorado flood plain may be great. Birds with body levels of DDE of the magnitude we report for laughing gulls from this area would be expected to encounter reproductive difficulties.

"The impacts of DDE and toxaphene on the fishes of the Arroyo Colorado are unknown. However, experimental studies have shown that both compounds are toxic to fish in minute quantities (Johnson and Finley, 1980); DDT and its metabolites alter certain physiological conditions in fishes including the normal balance of serum amino acids, thyroid activity, and the ability to withstand stress. Also, the mortality of fry produced by treated parents is high.

Table II-24 DDE residues (ppm) in whole fish at NPMP Station 16 (Mission, Texas)

Year	DDE Channel Catfish	DDE Blue Catfish
1969	2.93	1.87
1970	7.27	3.98
1971	4.17 2.51	3.75 6.18
1972	7.2	4.4
1973	2.7 3.1 1.9	-
1974	0.21	0.73 1.3
1976	1.7	-
1978		2.53

Table II-25 DDE residues (ppm wet weight) in composite samples of blue catfish (Ictalurus furcatus) and gizzard shad (Dorosoma cepodianum) at freshwater sites in the Arroyo Colorado drainage in 1978 (White et al., in press)

Site	Blue Catfish	Gizzard Shad
McAllen	16.7	16.0
San Juan	11.2	18.8
Upper LLano	27.4	
Harlingen	10.6	20.8
Port of Harlingen	24.1	9.6
	Mean = 18.0	16.3

"Regardless of the routes of contamination, our data indicate that fishes and birds of the Arroyo Colorado contain DDE and toxaphene residues that are within or above the range known to cause population declines. More importantly, the contaminated Arroyo Colorado empties into the Laguna Madre, one of the most extensive breeding and nursery grounds for fish and wildlife in the United States.

"Studies are under way to determine the reproductive success of fish-eating birds nesting in the Laguna Madre near the mouth of the Arroyo Colorado and to evaluate the effects of pollutants, such as DDE, on reproduction. At present, results are incomplete, but data thus far indicate that eggs of some species are high in DDE, eggshells are thin, and reproduction is poorer than in birds at other localities along the Texas coast (White, unpubl.). Additional research is needed to assess the impacts of pesticides on fishes and aquatic invertebrates in this heavily contaminated area of the lower Rio Grande Valley, Texas" (White et al., 1983a).

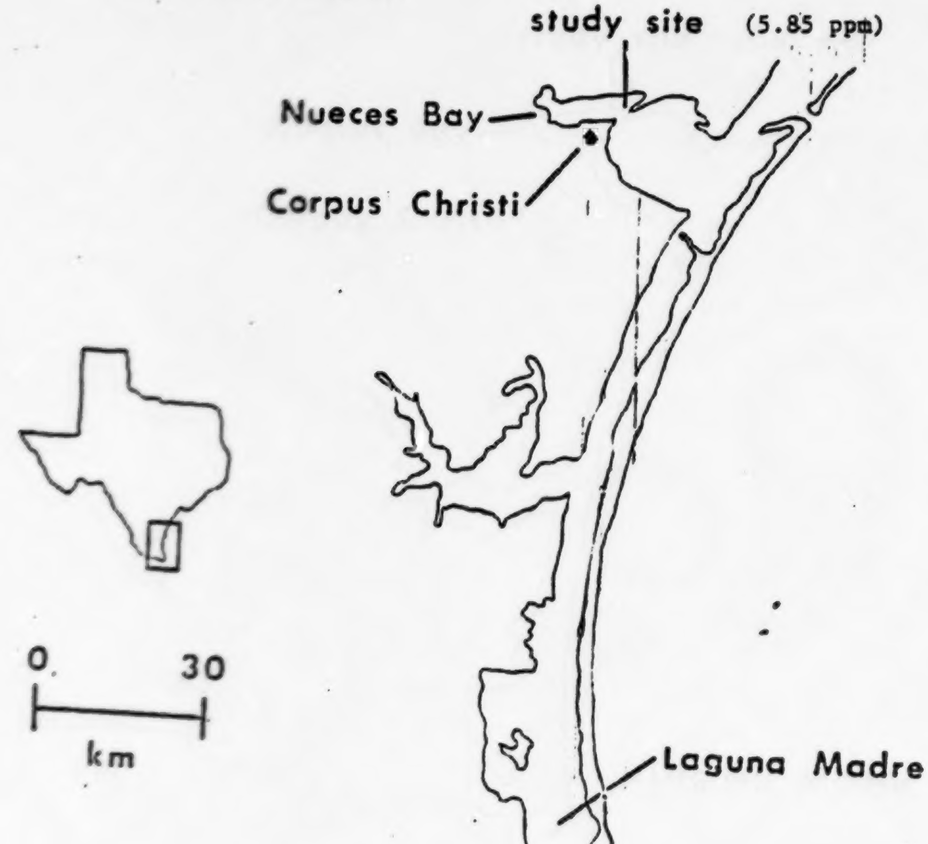
b. Sensitive Wildlife in South Texas

White et al. (1983b) report that migratory shorebirds feeding downstream from agricultural areas, at the mouth of the Arroyo Colorado, significantly accummulate DDE during their residence in the area and that "potentially dangerous levels (12 to 68 ppm) in a large proportion (40 percent of the long-billed dowitchers...and to a lesser extent American avocets' were observed." Moreover, White et al. note, "In addition, the shorebirds with high DDE residue levels may pose a significant hazard to peregrine falcons (Falco peregrinus) and other sensitive raptors that occasionally prey on them." The Laguna Madre is an important migratory resting point for peregrine falcons (Henny, 1984).

Colonies of black skimmers in the Laguna Madre, into which the Arroyo Colorado empties (Figure II-8), are also heavily contaminated with DDE (White et al. unpubl.; U.S. Department of Interior, 1983). Residues in eggs ranged up to 51 ppm with shells four to 12 percent thinner than museum specimens (pre-DDT era). Fish eaten by skimmers were collected where adult birds were seen feeding and from the crops of chicks; DDE was detected in 87 percent of the fish samples and ranged from 0.1 to 1.5 ppm with an overall mean of 0.64 ppm (wet weight). The authors noted that black skimmers migrate to Mexico and though this is a possible source of the observed DDE-egg residues, the Texas coastal environment is a more likely source given the residues found in fish. They also note that Louisiana and Mississippi colonies of black skimmers have residues 4-fold lower, even though they also winter in Mexico. Populations of black skimmers have decreased in south Texas an estimated 22 percent since the early 1970s for has yet undetermined reasons.

Figure II-8 Location of black skimmer study sites. Pesticide concentrations shown are the mean DDE residues in eggs at each colony.

(White et al. unpubl.)


study site (5.85 ppm)
Nueces Bay
Corpus Christi
0 30
km
Laguna Madre
Port Mansfield
(6.63 ppm)
agricultural drains
study sites
Arroyo Colorado
Laguna Vista
(8.26 ppm)
Mexico

4. Florida

The Agency's records show that dicofol use on citrus accounts for virtually all of the dicofol used in Florida. Estimated use in Florida in 1980 was 856,800 pounds or roughly one-third of all U.S. usage.

The Florida Department of Agriculture and Consumer Services analyzed dicofol products sold in Florida 1984 for DDTr contamination (Table II-26). Total DDTr contamination in ten product samples ranged from 3.0 percent to 15.7 percent of the advertised dicofol concentration. A 42 percent active ingredient product (representative of dicofol concentrations as used in large agricultural treatments, Inman, 1984) contained 5.9 percent total DDTr of which 1.6 percent was DDE. Based on the contamination level in this product (5.9 percent and the 1980 state-use total (856,800 pounds) dicofol applications result in a DDTr release in Florida of 50,551 pounds (which includes 13,700 pounds DDE).

1. Environmental Residues

NPMP fish residue sampling occurred at four stations in Florida: St. John's River, St. Lucie Canal, Suwanee River and the Apalachicola River. Samples were not collected after 1973 at St. John's River or Suwanee River station's thus these sites do not provide adequate data for trend analysis. DDE residues did not change statistically at Station 13 on the Applachicola River between 1974-1979 (Schmitt et al., 1983), but this site is in Florida's panhandle where citrus is not a significant crop. Station 12 on St. Lucie Canal, which is in a citrus growing region, showed a statistically significant reduction in DDE from 1974-1979 (Schmitt et al., 1983). The Agency analyzed the data for Station 12 on a pooled-species basis and found significant reductions in DDE and DDT (Table II-27 and Figure II-9) when the data are considered in their entirety (1969-1980). The three most recent NPMP surveys at Station 12 however, show possible recent stabilization in the DDTr residues:

		1976	1978	1980
White catfish				
	DDE	0.14	0.11	0.16
	DDTr	0.28	0.17	0.22
Largemouth Bass				
	DDE	0.09	0.09	0.17
	DDTr	0.15	0.15	0.17

Table II-26 DDTr contamination in dicofol products sampled in Florida in 1984. Analyzed by Division of Chemistry, Florida Department of Agriculture and Consumer Services.

Avertised % Dicofol	10%	18.5%	18.5%	18.5%	3.0%	4.13%	42.0%	18.5%	3.0%	3.0%
Sample #	54331	54131	54651	54235	54341	54210	546251	54927	54662	54769
% Dicofol	11.1	19.1	20.0	19.1	3.3	5.2	45.3	18.9	3.9	3.1
% OP DDT	0.009	0.021	0.045	0.002	0.002	0.002	0.083	0.023	0.002	0.031
% PP DDT	0.015	0.007	0.152	0.012	0.017	0.005	0.015	0.015	0.001	0.021
% OP DDE	0.192	0.139	0.159	0.247	0.071	0.013	0.581	0.299	0.077	0.085
% PP DDE	0.026	0.037	0.063	0.040	0.014	0.014	0.080	0.040	0.009	0.009
% OP ER8[1]	0.004	0.079	0.081	0.052	0.131	0.001	0.324	0.074	0.048	0.035
% PP ER8[1]	0.051	0.975	0.446	0.444	0.235	0.274	1.610	0.961	0.187	0.167
Total DDTr as Percent of Advertised Dicofol	3.0	6.8	5.1	4.3	15.7	7.5	5.4	7.6	10.8	11.6
DDE as % of dicofol	2.2	0.95	1.2	1.55	2.8	0.65	1.6	1.8	2.9	3.1

[1] DDT-Cl: 1,1-Bis(p-chlorophenyl)-1,2,2,2-tetrachloroethane.

Table II-27 Regression statistics for NPMP fish samples 1969-80, St. Lucie Canal, Florida. All values were log10 transformed; samples with non-detectable residues were assigned a value of 0.005 (1/2 detection limit).

Species	Residue	F	R^2	P>F
White catfish	DDE	0.69	0.12	0.44
N=7	DDT	3.07	0.38	0.14
1972-78				
Bluegill	DDE	0.17	0.03	0.70
N=7	DDT	0.01	0.002	0.93
1969-74				
Largemouth Bass	DDE	4.73	0.32	0.05
N=12	DDT	12.24	0.55	0.006
1969-78				
Channel catfish	DDE	5.05	0.46	0.07
N=8	DDT	5.77	0.49	0.05
1969-76				
Pooled data	DDE	6.7	0.17	0.01
N= 34	DDT	14.4	0.31	0.006
1969-80				

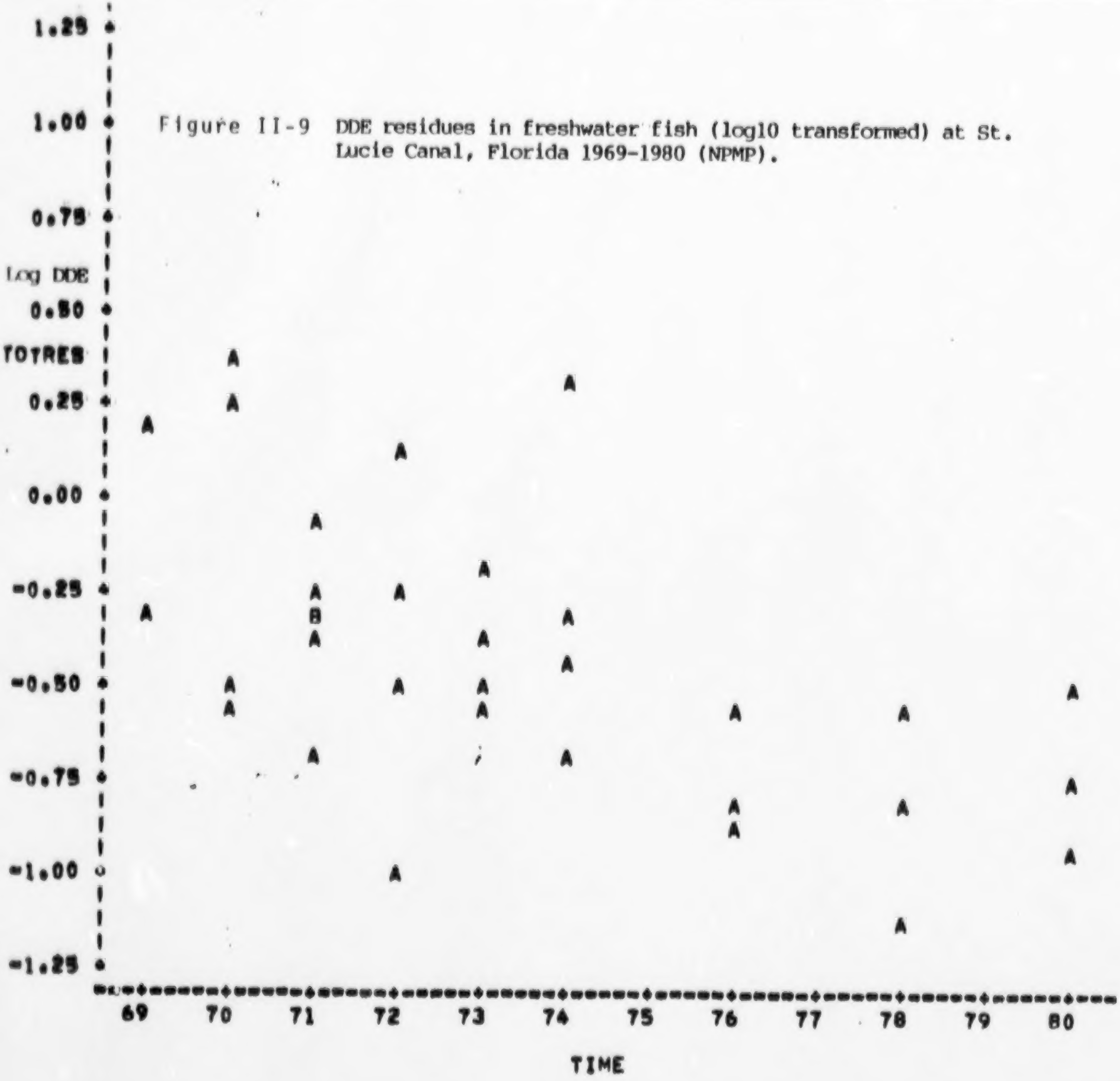


Figure II-9 DDE residues in freshwater fish (log10 transformed) at St. Lucie Canal, Florida 1969-1980 (NPMP).

In 1982 the Florida Game and Freshwater Fish Commission analyzed fish for pesticide residues from Lake Apopka following reports that catfish contained DDT residues high enough to raise possible public health concerns (State of Florida Game and Fish Commission, 1982). Lake Apopka (Figure II-10) is a large shallow inland lake near citrus groves. Results of this survey show DDE + DDD residues in pooled samples of brown bullhead ranging from 0.066 ppm to 0.525 ppm. One yellow bullhead had a residue of 0.403 ppm; pooled samples of white catfish had residues of 0.319 ppm and 0.40 ppm (DDD + DDE). Sunshine bass had residues ranging from 0.089 to 0.491 ppm (DDD + DDE). Largemouth bass in two pooled samples had residues of 0.03 and 0.12 ppm (DDD + DDE).

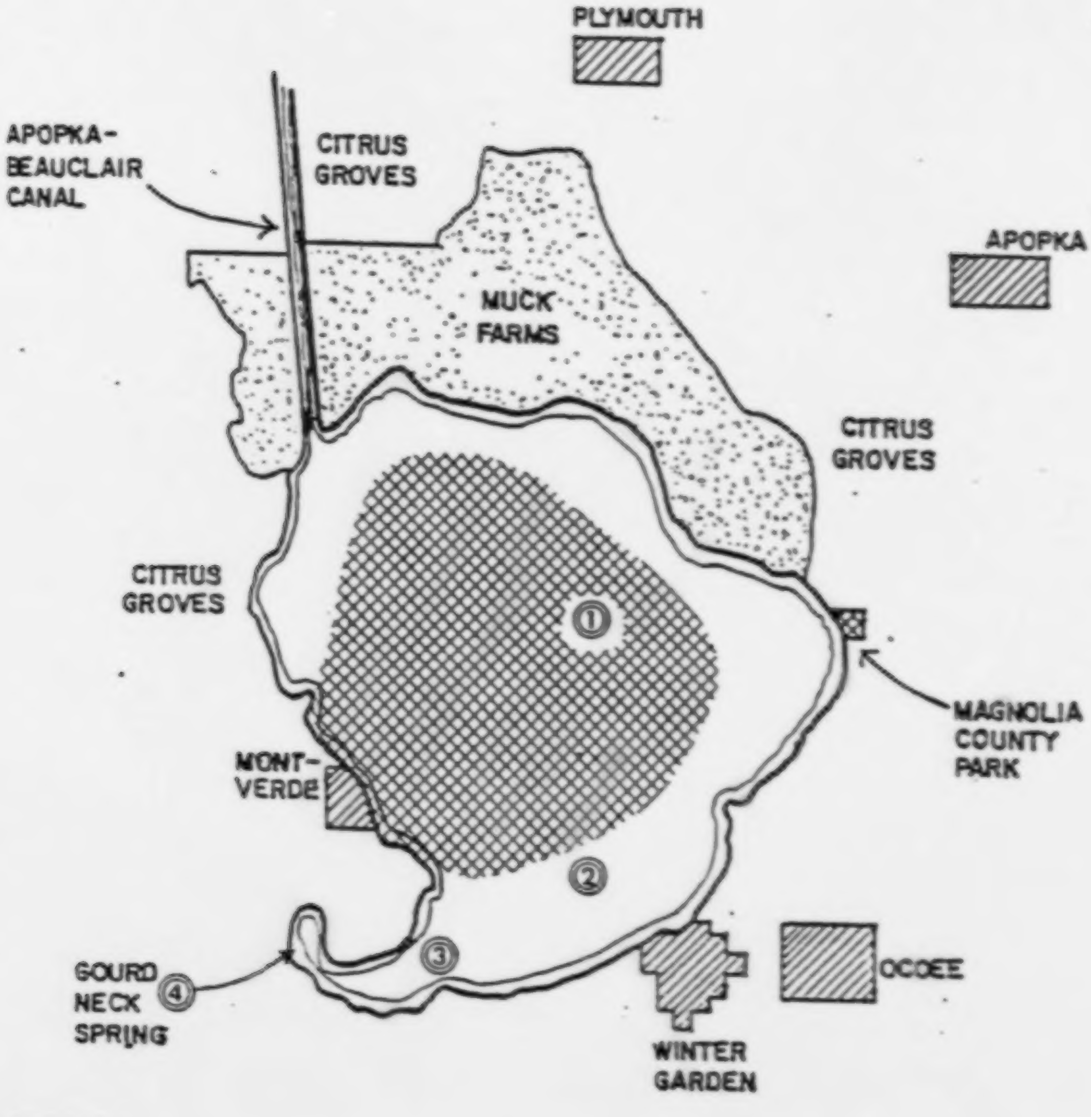
Florida fish monitoring is of residues in fish flesh (fillets). Such analysis may be useful for determining human exposure, but fish-eating wildlife will frequently consume whole fish which may have residues two or more fold greater than those found in flesh samples. Viewing the 1982 Lake Apopka fish residue data following application of a 2x conversion-factor suggests that mean whole-body residues may be above 0.5 ppm (DDD +DDE). A chronic exposure at this concentration would likely result in adverse reproductive effects on birds.

b. Sensitive Wildlife in Florida

Wood storks are large wading-birds that occur in the southern U.S., primarily in Florida. Population levels have decreased considerably in recent decades (1930: 20,000, 1980: 4,800; Fleming et al. unpubl.) and the species has recently been added to the Federal Endangered Species List. Contaminant studies of wood storks were not undertaken until after the cancellation of DDT; thus the effects of the pesticide on reproduction during the time of peak DDT exposure is unknown. The primary reasons given for its recent listing are destruction and alteration of its feeding habitat (Endangered Species Technical Bulletin, 1984).

Studies completed since the cancellation of DDT have shown that wood stork eggshells are significantly thinner than pre-pesticide era specimens (<1947) and that shell thickness is negatively correlated with DDE-egg concentrations. In 1973 (Ohlendorf et al., 1978), ten wood stork eggs were collected from nests at Merritt Island National Refuge in Florida. Egg contents contained 4.0 ppm DDE (geometric mean, wet weight basis) and eggshells were 8.9 percent thinner than eggs collected before 1947. Residues of DDE were highest in wood stork eggs relative to those found in eggs of 12 other species collected at the site. The correlation of DDE in eggs with decreasing shell thickness approached significance and was higher than for other contaminants measured. In 1982, Fleming et al. (unpubl.) collected one wood stork egg from each of five nests at eight colonies in central and northern Florida. The previously studied

Figure II-10 Lake Apopka, Florida and environs (State of Florida Game and Fish Commission 1982).


PLYMOUTH
APOPKA-BEAUCLAIR CANAL
CITRUS GROVES
APOPKA
MUCK FARMS
CITRUS GROVES
CITRUS GROVES
①
MAGNOLIA COUNTY PARK
MONT-VERDE
②
③
GOURD NECK SPRING ④
OCOEE
WINTER GARDEN

Merritt Island site was included. DDE concentration in egg contents ranged from 0.16 to 9.4 ppm with a geometric mean of 1.6 ppm (wet weight). DDE was negatively correlated with eggshell thickness ($r= -0.48$, $P \leq 0.01$). They also report that DDE concentrations were higher in eggs from nests in which at least one egg did not hatch compared to residues in eggs from nests where all eggs hatched. Flemming et al. concluded:

> "Our data suggest a possible link between DDE and hatching success of Wood Stork eggs, particularily at DDE concentrations present in earlier years.
>
> "Thus one must not dismiss organochlorines, DDE in particular, as possibly contributing to the poor reproductive performance of Wood Storks during the past three decades."

The DDE residues affecting wood storks are probably of many origins ranging from global atmospheric-borne DDE to residual pre-cancellation DDT. Wood storks forage for fish and other aquatic animals in waters that receive drainage from citrus areas. Therefore dicofol must also be considered a possible source. The dicofol source is of special concern for the Merritt Island Refuge population, contract farmers are permitted to tend citrus groves on the grounds of the refuge (greater than 2500 acres) (Johnson, 1984). Refuge records show that between 1979 and 1982 18,000 pounds of dicofol were used at the site, which (by recent Florida analysis of dicofol) indicates a possible local release of approximately 1000 pounds DDTr (estimated from DDTr in sample #546251, Table II-26). Use of dicofol at the refuge has not been permitted since 1982 based on concern over DDTr contamination (Johnson, 1984). Dicofol applications to citrus near in-land lakes such as Lake Apopka may also contribute to wood stork DDE-exposure. As Ohlendorf et al. report, wood storks fly as much as 125 km to obtain food during nesting periods. Following nesting they disperse over an even greater area.

DDE has been shown to cause poor reproduction in bald eagles and these effects have played a major role in their population dynamics (Wiemeyer et al., 1984). Florida bald eagles have been reported to be reproducing at 'near normal' levels in recent years (Nesbitt, 1984). Nonetheless, the estimated 350 pairs in Florida (Kale, 1984) remain on the federal endangered list.

Wiemeyer et al. (1984) have summarized available bald eagle egg-contaminant and shell thickness data for the period 1969-79. Their findings show that Florida bald eagles continue to have hazardous concentrations of DDE in their eggs and eggshell thinning sufficient to affect at least a portion of the population. Correlating DDE-egg residue and nest productivity data for all bald eagles in the U.S. indicated that when egg residues are below 3 ppm (wet weight) reproduction is approximately normal and when residues are greater than 5.1 ppm DDE, productivity drops remarkedly. Most of the egg residue values reported since the cancellation of DDT (1972) for Florida exceed 3 ppm.

Year	Site	DDE	DDD	DDT
1975[a]	Camp Key	13	0.08	-
1976	Pine Island	12	0.61	0.06
1976	Deer Key	8.6	0.12	0.04
1977	Pine Island	3.5	0.07	-
1977	Pine Island	3.2	0.17	-
1979	Pine Island	2.0	-	-
1981[b]	Fort Meyers	4.9	0.47	-
1983[b]	Brevard County	1.6	-	-

[a] Data from Wiemeyer et al., 1984 except as indicated
[b] Wiemeyer, 1984

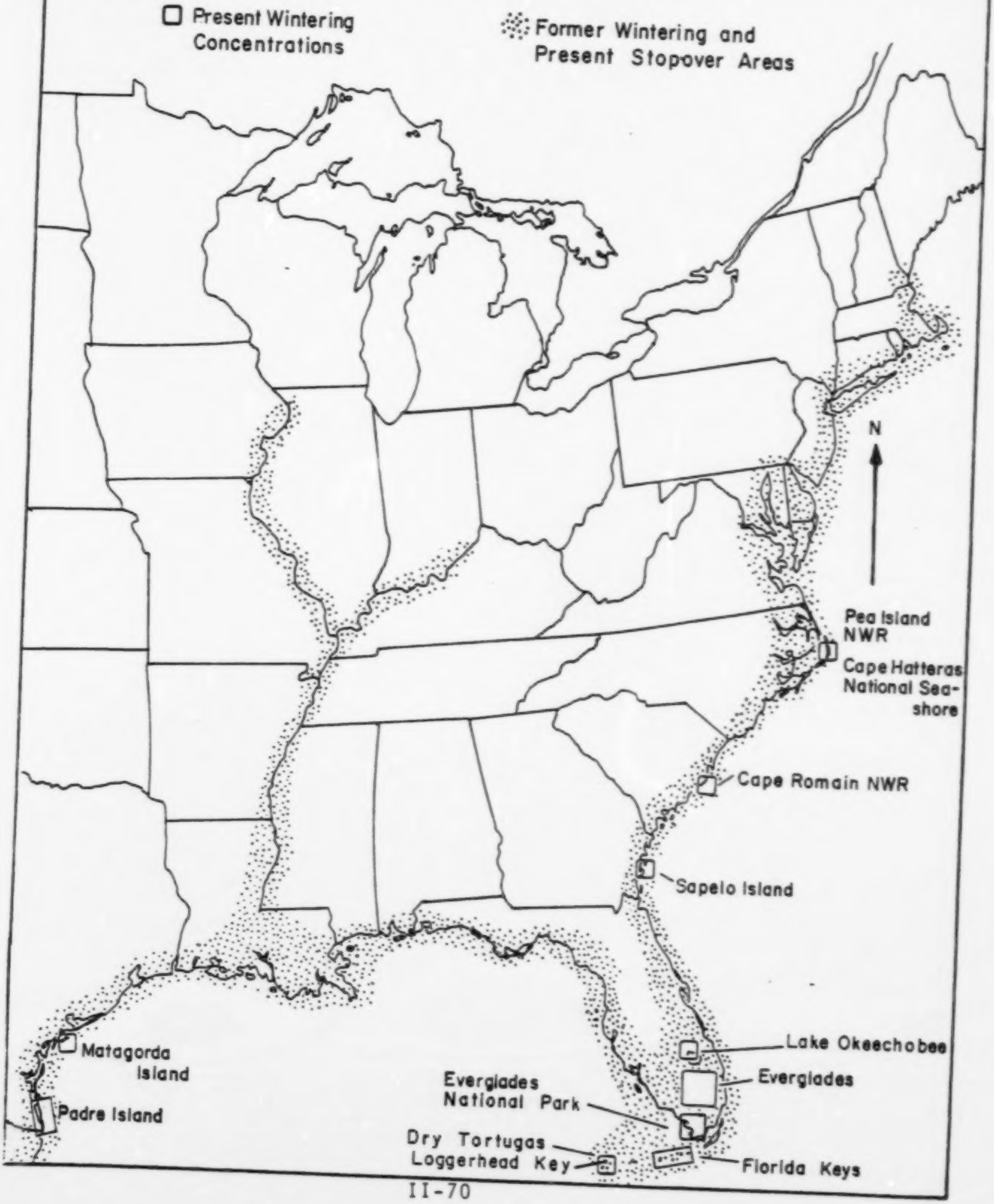
Wiemeyer et al. describe eggshell thinning in Florida in the 1969-79 period as moderate (13 percent compared to pre-1946 samples). They note, however, that 20 percent of the Florida eggs had severe thinning, i.e. greater than 20 percent.

Bald eagles in Florida occur in both marine and fresh-water environments. Shallow eutrophic inland lakes (such as Lake Apopka) that are near or adjacent to citrus production areas, and thus that have a high potential to receive dicofol drift or runoff, are used frequently by bald eagles and other fish-eating birds such as ospreys (Nesbitt, 1984).

Peregrine falcons are not resident in Florida; however, migratory peregrine falcons occupy habitat in or adjacent to citrus growing regions in Florida (Figure II-11). Thus some DDTr exposure from dicofol may occur by consumption of small birds (their principal food) that have acquired residues in treated areas.

PRESENT AND FORMER WINTERING AREAS

Figure II-11 Peregrine falcon wintering areas (U.S. Dept. of Interior 1979A)


☐ Present Wintering Concentrations
Former Wintering and Present Stopover Areas
N
Pea Island NWR
Cape Hatteras National Seashore
Cape Romain NWR
Sapelo Island
Lake Okeechobee
Everglades
Everglades National Park
Dry Tortugas
Loggerhead Key
Florida Keys
Matagorda Island
Padre Island

C. EXPOSURE ANALYSIS

1. Introduction

The Agency prepared exposure calculations for the two major dicofol use patterns--citrus and cotton. The Arroyo Colorado waterway of southern Texas was chosen because of the high level of dicofol used on citrus and the important aquatic bird habitats in that drainage area. The Agency selected Kings County, California, for the exposure calculations for cotton because of the availability of use data for that area and information indicating that Kings County is frequented by winter migrations of waterfowl.

2. Exposure Analysis for Kings County, California

Cotton has historically been treated with dicofol at a rate of about one pound per year. Exposure calculations for Kings County are of two types. An overall mass balance analysis was prepared to demonstrate the potential contribution of dicofol use to the total DDTr loading of the county. Additionally, the Agency prepared a specific aquatic exposure analysis related to cotton cultivation in Kings County.

a. Kings County Mass Balance Analysis

In preparing the estimate of exposure in Kings County, the Agency used the following assumptions.

1. Soil is by far the largest environmental sink for DDTr and the fate of DDTr in the soil would determine the overall dissipation rate in Kings County.

2. The dissipation half-life of DDTr in soils is seven years (Lichtenstein et al., 1971).

This is not a true degradation half-life because volatilization of DDT from the soil accounts for much if not most of the loss. Additionally, it is noted that longer (Buck et al., 1983) and shorter (Beyer and Gish, 1980) dissipation half-lives have been determined, and the seven year value represents an intermediate estimate.

3. DDTr dissipates from Kings County according to first order kinetics.

4. Apart from insignificant public health use and use of existing stocks, DDTr soil loading due to the use of DDT products ended early in 1972.

5. Dicofol is contaminated with DDTr at a level equal to ten percent of that of the active ingredient.

6. Use on cotton accounts for all significant dicofol and DDT use in Kings County.

7. Dicofol is applied to cotton in Kings County at a rate averaging one pound per acre.

8. Historically, DDT was applied to cotton at a rate averaging 4.8 pounds per acre (Eckerman, 1984).

9. In the 60's there was an average of 77,500 acres of cotton in Kings County and this climbed to an average of 275,000 acres in the 70's. DDT and dicofol were each used at a constant annual rate from 1958 until 1970 (see assumptions #7 and #8). The Census of Agriculture (U.S. Department of Commerce, 1981) notes that the acreage of cotton in Kings County was in the 250,000 range by 1978. The Agency assumes, for lack of better data, that the cotton acreage increased linearly from 77,500 acres to 250,000 in the period of 1971 to 1978 and that it has remained constant since that date and will remain at that level in the future.

b. Results and Conclusions

The results of the mass balance analysis demonstrated that, using reasonable estimates of DDTr dissipation rates and reasonable estimates of the past, current, and future use of dicofol and DDT, dicofol could be a significant contributor to the current and future DDTr contaminant levels found in Kings County soil, water and biota. Specifically, by 1984, the Agency estimates that the total loading of DDTr in Kings County due to DDT use could reasonably be estimated to be about 850,000 pounds versus an estimate of 200,000 pounds due to the use of dicofol (see Figure II-12). By the year 2000, it is estimated that the total loading of DDTr in the county could reasonably be expected to fall to 220,000 pounds of DDTr if dicofol were terminated versus a lowering to 450,000 pounds of DDTr if the uses were maintained (see Figure II-13). In other words, by the year 2000, environmental DDTr residues may be twice as high if dicofol use continues than they would be if its use was terminated.

3. Aquatic Exposure Assessment for Flooded Fields in the Old Tulare Lake Basin, Kings County, California

During the late fall and winter, flocks of waterfowl migrate to the San Joaquin Valley. During this period, most of the cotton fields of Kings county are flooded in an agricultural practice called "preirrigation" (Sutherland, 1984).

Euliss (1984) indicates that chironomid midge larvae and other invertebrates in the preirrigated fields of Kings County, California may provide important sources of forage to wintering waterfowl. The exposure to these forage organisms would presumably be highest during years when the cotton fields have been planted with alternate crops such as grain which would tend to be more attractive to foraging waterfowl. In calculating the aquatic residue level of DDTr in the waters of the flooded fields, the Agency made the following assumptions:

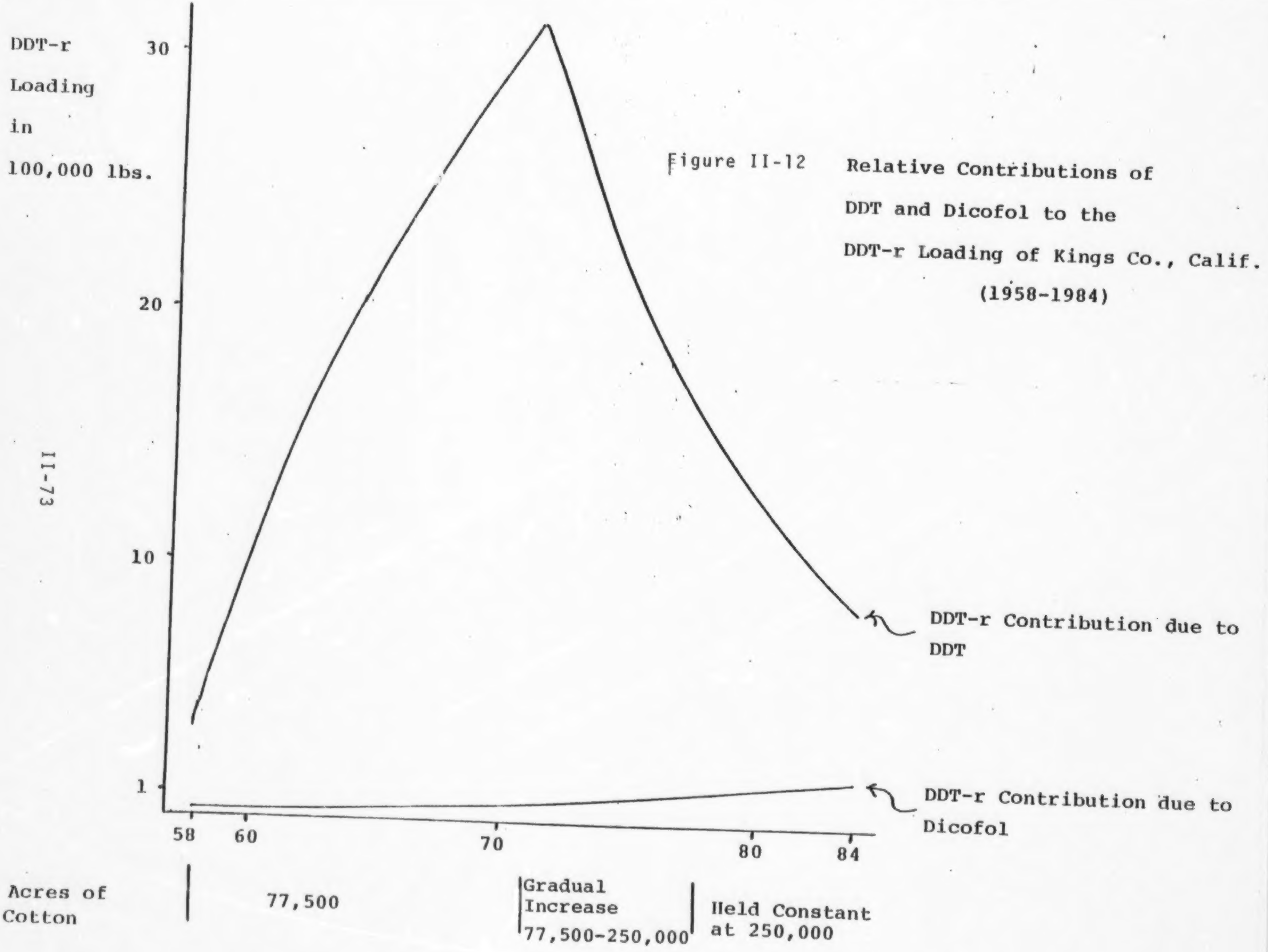
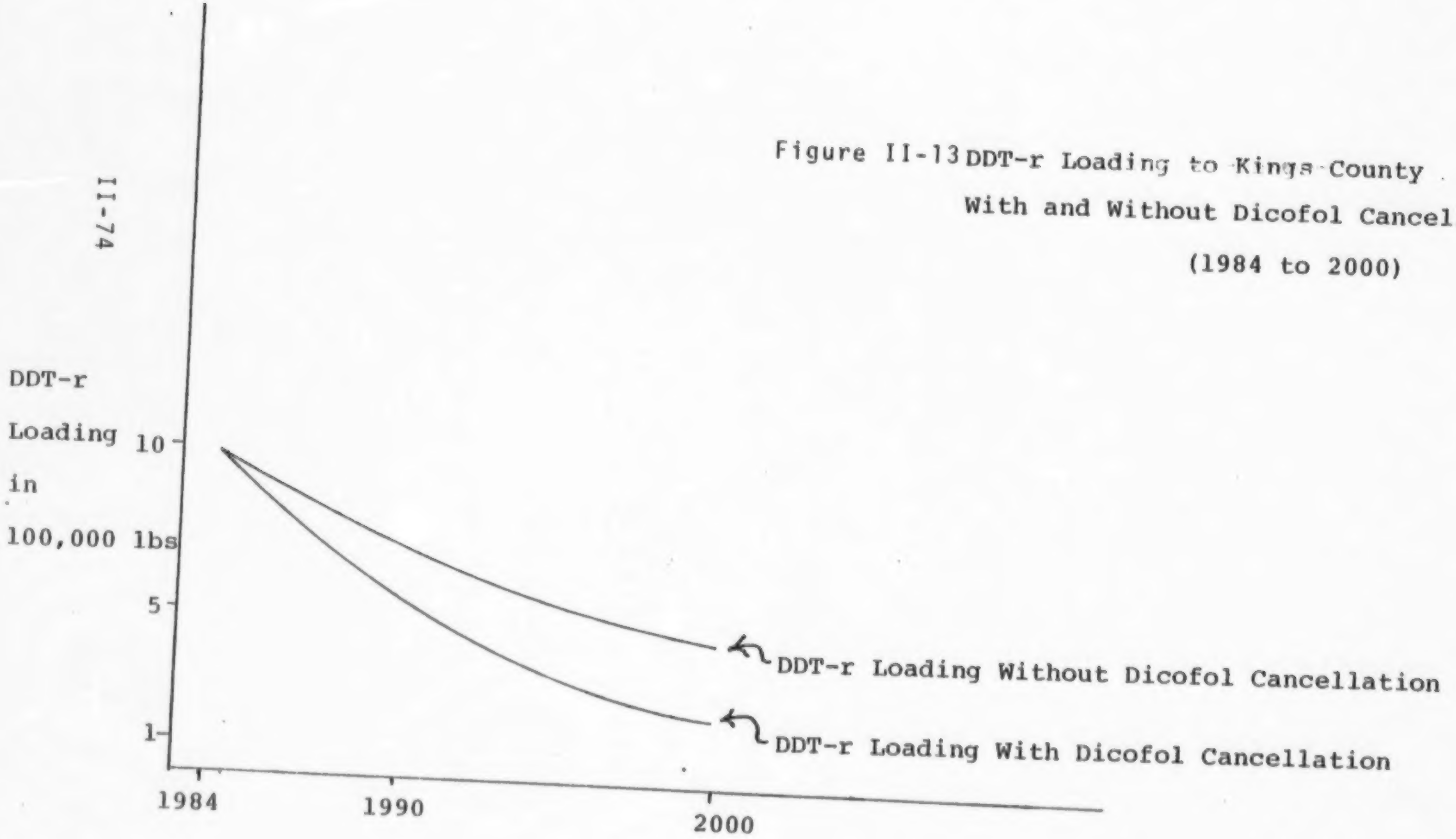


Figure II-12 Relative Contributions of DDT and Dicofol to the DDT-r Loading of Kings Co., Calif. (1958-1984)

Figure II-13 DDT-r Loading to Kings County
With and Without Dicofol Cancellation
(1984 to 2000)



1. Cotton is planted for three consecutive years followed by four years of other crops.

2. Dicofol is applied only to the cotton.

3. The rate of dicofol application is one pound per acre. Two applications are made during one of the years in a three year series and only one application is made during each of the other two years.

4. The first application is made when the cotton foliage covers less than 50 percent of the field and the second application is made when the canopy covers the field.

5. The amount of pesticide reaching the ground immediately after application is proportional to the canopy cover (Willis, 1984). An additional ten percent reaches the ground subsequently due to dry and wet fall (U.S. Department of Agriculture, 1980). This yields 60 percent soil interception on the first application and 10 percent interception on the second.

6. The soil half-life of DDTr is seven years (Lichtenstein, 1971).

7. The field is flooded to a depth of two feet.

8. The field is plowed to a depth of one foot prior to flooding and all pesticide is free to exchange with the water column.

9. The cotton plant is disced into the soil in the fall, but no significant loading is contributed because the half-life from plant surfaces is relatively short (Ballee et al., 1970).

a. Calculation Methodology

To calculate the aquatic residue, DDTr loadings due to dicofol soil were accrued over a 16-year period considering the effects of interception by the cotton plants and dissipation. In the sixteenth year, the soil residues are partitioned to the water column assuming equilibrium between the water column and the disced, top two inches of soil.

b. Results

On the basis of fundamental physical-chemical principles, it is estimated that sixteen years of dicofol use could result in 70 parts per trillion (ppt) of DDTr in the water column of preirrigated fields (Hitch, 1984).

In a flow-through laboratory study, Derr and Zablick (1972), using treatment levels in the range of the Agency's calculated exposure, demonstrated that the Chironomus midge could be expected to bioaccumulate DDE 20,000 fold above the aquatic concentrations. A 20,000 fold bioaccumualtion factor would give rise to an estimate of 1.4 ppm DDTr (wet weight) in the chironomids.

As an example of the possible exposure to peregrine falcons and bald eagles by waterfowl, the Agency used the example of a one kilogram duck. It is reasonable to assume that the ducks would feed heavily for about two months on the chironomids in flooded fields which had recently been cultivated in cotton (Euliss, 1984). The biological half-life of DDTr in large waterfowl is long (Longcore and Stendell, 1977; and Haegele and Hudson, 1974). The Agency therefore assumes that the amount of DDTr eliminated or metabolized by the ducks within 60 days would be insignificant. The total accumulation during this period would be equal to the typical food consumption of a duck (assumed to be 200 grams per day) multiplied by the chironomid contamination level (1.4×10^{-6}):

$$60 \text{ days} \times 1.4 \times 10^{-6} \times 200 \text{ grams} = 0.017 \text{ grams DDTr}$$

Dividing the 0.017 grams by the reasonable estimate of an adult duck's weight (1 kg), one would estimate that the total body residue of the duck would reach 17 ppm. The Agency would not project that overwintering ducks feed exclusively in flooded cotton fields, but cotton culture and dicofol use is so extensive in Kings County that it is reasonable to assume that ducks feed in DDTr contaminated fields frequently enough to drive their body burdens above the reproductive levels which have been indicated for sensitive raptors. The dietary effect level for the peregrine falcon may be as low as 0.1 ppm (wet weight) (Pruett-Jones, 1981), while analysis of prey species of bald eagles experiencing eggshell thinning were generally below 0.3 ppm DDE (Wiemeyer et. al., 1978).

4. Arroyo Colorado EXAMS Model

Because fish-eating birds may be exposed to residues of DDTr exceeding dietary levels known to impair reproduction, the Agency developed a model to estimate the level of DDTr residues in water resulting from the use of dicofol (Hitch and Reinert, 1983). The simulation relies upon the Exposure Analysis Modeling System (EXAMS). The Arroyo Colorado waterway of southern Texas was chosen because of the high level of dicofol used on citrus and the important aquatic bird habitats in the drainage area. Under the conditions of steady-state chemical loading, this model predicts the equilibrium concentration in a water body. Although there are various uncertainties associated with the use of mathematical simulations to describe environmental processes, the use of this model is believed to be an appropriate tool to estimate exposure to aquatic environments. The chemical input to the river system was estimated based on the following assumptions:

1) The amount of dicofol used each year in this drainage basin is 100,000 pounds. This is based on the estimate of 25,000 acres of citrus with drainage into the Arroyo Colorado,

and the estimate that up to four pounds of dicofol active ingredient are used once per year on citrus. Using the highest label rate for a single application may partly compensate for the legal use of multiple applications at less than the maximum rate.

2) For purposes of this simulation, the water in the river basin was assumed to be free of DDTr prior to the introduction of contaminated dicofol, which yields the EXAMS steady state concentration. Even though it is documented that background levels of DDTr occur ubiquitously throughout the environment, this assumption is necessary to calculate the DDTr burden in fish that results solely from the use of dicofol.

3) The amount of DDTr added to the environment was assumed to be ten percent of the dicofol active ingredient applied. Ten percent is approximately the average DDTr content of currently registered technical products. The model's residue predictions are a direct linear function of the loading so that aquatic residues for any level of product contamination can be estimated by proportionality.

4) The physical characteristics of DDT and DDE vary slightly and the modeling capabilities required the choice of one set of chemical parameters. From a calculation standpoint, counterbalancing factors mitigated the importance of choosing the physical properties of DDT or DDE for the purpose of aquatic fate modeling to predict the eventual concentration of DDE precursors in fish (Hitch and Reinert, 1983). For the EXAMS model, the physical parameters for p,p'-DDT, the most extensively studied analog, were used throughout the simulation and the environmental exposure assessment.

5) The Agency assumed that most of the DDTr reaching the Arroyo Colorado was transported by surface water running off the immediate drainage area in which dicofol had been used. A recent review of the available literature (Wauchope, 1980), pesticide runoff concluded that DDT consistently shows long term losses of two to three percent of the amount applied. Therefore, two percent of the DDTr applied was assumed to reach the Arroyo Colorado as a consequence of surface water runoff.

Using these assumptions, EXAMS predicted a steady state water column concentration of 9 parts per trillion (ppt) DDTr. Fish bioaccumulation factors have been estimated to be over 1,000,000x (Reinert, 1970). The Agency, therefore, estimates that fish residues (total body wet weight) of 9 ppm might be expected. These DDTr residue levels in fish exceed dietary levels shown experimentally to reduce eggshell thickness. Effects on avian reproduction have been documented experimentally at dietary levels as low as 0.6 ppm DDE (wet weight). Monitoring studies of brown pelicans have indicated reproductive effects at lower dietary concentrations. Because some of the constituents of DDTr are known or expected to degrade to DDE, the Agency concludes that the residue levels of DDTr in fish which would result from currently registered dicofol products pose a significant risk to certain species of birds.

D. POTENTIAL HUMAN HEALTH EFFECTS

1. Oncogenicity of Dicofol and DDTr

As indicated in the Position Document 1, the Agency is concerned with the oncogenic effects of the DDTr contaminants of dicofol and found that studies of dicofol *per se* were unacceptable because of uncertainties about the composition of the test material. The Agency has reexamined the tests done to confirm the composition and finds little basis for concluding that the test material was other than technical dicofol. Steps are underway to establish the validity of the NCI studies as representative of technical dicofol. Additionally, because substantive new information on the oncogenicity of DDTr has been generated since the Agency's last review (EPA, 1980), the Agency has undertaken a thorough review of the oncogenic data base for dicofol and its DDTr contaminants, namely DDT, DDE, and DDD. The purpose of this review is to reassess the weight of evidence for carcinogenicity and to provide appropriate measures of oncogenic potency for the chemicals so that a more reliable risk assessment can be conducted. The data base for dicofol and DDTr under review includes experimental studies of the following species.

Mouse - Four multigeneration and six single generation

Rat - Nine single generation

Hampster - Two single generation

Dog - One four-year study

Monkey - Four, up to 12 years in the Rhesus monkey

A human epidemiological study is also under review.

The positive effects found in these studies have mainly involved both benign and malignant liver and lung tumors in the mouse. Mouse liver tumors are also associated with chronic exposure to technical dicofol and some of the other DDTr analogs and the significance of these for risk assessment is under review.

Included in the weight of evidence review are numerous reports dealing with the genotoxic effects of DDTr. The role of DDT as a promoter of carcinogenesis is also under review.

2. Human Toxicity of Alternatives to Dicofol

A synopsis of the toxicological data base for the major alternative miticides is provided in Table II-28. Chlorobenzilate is oncogenic and, as a result of the Rebuttable Presumption Against Registration process in 1979, its use was restricted

Table II-28
Toxicity Data Base for Alternatives to Dicofol/Kelthane

Pesticide	Pivotal Data	Data Gaps	Basis for ADI Tolerance/%ADI
COTTON USE			
Sulfur CAS # 812 CFR 180.2	GRAS list Acute oral LD_{50} > 3000 mg/kg (HDT) Mutagenicity: not on auxotrophic mutant of E Coli Oncogenicity: one year dermal, mouse NOEL 50 mg/mouse/day	None	Not established Material is on the GRAS list CFR 180.2
Propargite (Omite) CAS # 130I CFR 180.259	2 Yr feeding, dog NOEL > 900 ppm (HDT) 2 Yr feeding, rat NOEL > 900 ppm (HDT) 3 generation reproduction, rat NOEL> 300 ppm (HDT) 18 mo. oncogenicity, mouse NOEL> 1000 ppm (HDT) Teratology, rat NOEL> 105 mg/kg/day (HDT) Teratology, rabbit NOEL> 10 mg/kg/day (HDT)	Mutagenicity data Metabolism data	Dog, feeding NOEL = 900 ppm Tolerance = 0.1 ppm (cottonseed) = 5.0 ppm (oranges) % ADI = 11.22
Cyhexatin NOT APPROVED FOR COTTON SEED			
Monocrotophos (Azodrin) CAS # 377 CFR 180.296	Teratology, rabbit NOEL > 2 mg/kg/day (HDT) 3 generation reproduction, rat NOEL = 2 ppm 2 year feeding, rat NOEL = 10 ppm 2 year feeding, dog ChE NOEL = 1.6 ppm Systemic NOEL = 100 ppm Mutagenicity a. Dominant lethal, NOEL > 4 mg/kg (HDT) b. Host mediated assay, weak mutagen high concentration (5 mg/ml) c. Chromosome assay, NOEL > 4 mg/kg (HDT)	Metabolism data Oncogenicity data	Dog, feeding NOEL = 1.6 ppm Tolerance = 0.1 ppm % ADI = 18.79

Table II-28 (continued)
Toxicity Data Base for Alternatives to Dicofol/Kelthane

Pesticide	Pivotal Data	Data Gaps	Basis for ADI Tolerance/%ADI
Methyl Parathion (parathion) CAS # 372 CFR # 180.121	Teratology, rat NOEL > 6 mg/kg/day (HDT) Teratology, mouse (ip) NOEL > 60 mg/kg (HDT) Mutagenicity, mouse chromosome aberrations NOEL = 1100 mg/kg (ip) 90 day feeding,dog NOEL = 0.3 mg/kg/day Oncogenicity, mouse not carcinogenic Oncogenicity, rat, not carcinogenic (FR vol 44 #103 pp 30448, 5/25/79) Note: New chronic rat data; toxicity to eyes (50 ppm); Tox. Branch may propose Special Review.	Metabolism data Mutagenicity data	Rat, older NOEL = 1 ppm Tolerance = 1.0 ppm (citrus) = 0.75 ppm (cotton seed) % ADI = 191.88
Carbophenothion	See Citrus Use		
Chlorobenzilate	See Citrus Use		
CITRUS USE			
Oxythioquino (Morestan) CAS # 576 CFR # 180.338	Teratology, rat NOEL > 750 ppm (HDT) 3 generation reproduction, rat NOEL = 60 ppm 2 year feeding, dog NOEL = 50 ppm Neurotoxicity, chicken NOEL > 5 mg/kg (HDT) 2 year oncogenic, rat NOEL = 12 ppm (Only dose tested) Several studies on rat show liver toxicity	Mutagenicity data Metabolism data Oncogencitity data	Rat NOEL 60 ppm (3 mg/kg) Tolerance = 0.5 ppm % ADI = 2.41
Propargite	See Cotton Use		
Ethion CAS # 427 CFR 180.173	Teratology, rat NOEL > 2.5 mg/kg/day (HDT) Teratology, rabbit NOEL = 0.6 mg/kg/day LEL = 2.4 mg/kg (fused sternabrae) Feto/maternotoxicity NOEL = 0.6 mg/kg Feto/maternotoxicity LEL = 2.4 mg/kg (increased resorptions/lower body weight)	Oncogenicity data Reproduction data Mutagenicity Subchronic neurotoxicity; Hen	Human NOEL 0.1 mg/kg Tolerance = 2.0 ppm % ADI = 128.83

Table II-28 (continued)
Toxicity Data Base for Alternatives to Dicofol/Kelthane

Pesticide	Pivotal Data	Data Gaps	Basis for ADI Tolerance/%ADI
	Mutagenic a. Ames NOEL 20,000 mg/plate b. yeast recombination NOEL 1000 ppm ChE Inhibition, Human NOEL plasma = 0.05 mg/kg/day NOEL RBC = 0.15 mg/kg/day Acute neurotoxic Hen, positive 1900 mg/kg (LDT)		
Carbophenothion CAS # 165 CFR # 180.156	3 generation reproduction, rat NOEL = 10 ppm 2 year feeding, dog NOEL < 5 ppm (INCOMPLETE STUDY) Metabolism, rapidly excreted into urine Acute delayed neurotoxicity NOEL = 330 mg/kg	Acute dermal LD_{50}, rabbits Acute inhalation LC_{50} rats Primary eye irritation Primary dermal irrita. Teratology, 2 species Chronic feeding, rat Oncogenicity, 2 species Mutagenicity, 3 tests	Dog, NOEL = 0.125 mg/kg Tolerance = 0.20 ppm (cotton seed) = 2.0 ppm (citrus) % ADI = 77
Fenbutalin oxide (Vendex/Miticide) CAS # 481DD CFR 180.362	Teratology, rat NOEL > 60 mg/kg (HDT) Fetotoxic NOEL > 60 mg/kg (HDT) Maternotox. NOEL = 30 mg/kg/ LEL = 60 mg/kg Teratology, rabbit NOEL > 10 mg/kg/day (HDT) 3 generation reproduction, rat NOEL = 50 ppm 18 month Oncogenic, mouse NOEL 100 ppm 2 year feeding, dog NOEL = 5 mg/kg/day 2 year oncogenic, rat NOEL > 600 ppm Metabolism, rat; mostly excreted unchanged Primary eye irritation, extremely irritating	Metabolism data	Rat, NOEL = 5 mg/kg/day Tolerance = 20 ppm % ADI = 71.33
Cyhexatin (Plictran) CAS # 884A CFR # 180.144	3 generation reproduction, rat NOEL = 12.5 ppm 3 generation reproduction, rabbit NOEL = 3 mg/kg/day (HDT) 2 year oncogenic, rat NOEL > 6 mg/kg/day (HDT) Mutagenicity, AMES NOEL = 2 mg/plate	Metabolism data Mutagenicity data Oncogenicity data No NOEL for dog feeding (< 0.75 mg/kg/day)	Rat, older NOEL = 12 ppm Tolerance = 2 ppm % ADI = 89.15

Table II-28 (continued)
Toxicity Data Base for Alternatives to Dicofol/Kelthane

Pesticide	Pivotal Data	Data Gaps	Basis for ADI Tolerance/%ADI
Chlorobenzilate CAS # 434 CFR # 180.109	2 generation reproduction, rat reproduction NOEL = 100 mg/kg (HDT) Systemic NOEL = 30 mg/kg 2 year feeding, dog NOEL = 500 ppm Oncogenic, mouse NOEL for males NOT reported, increased tumors males 3200 ppm (LDT), no effect females USE LIMITED TO CITRUS	Reproduction, Dog, feeding Teratology data Mutagenicity data	NOEL = 12.5 mg/kg Tolerance = 5 ppm (citrus) = 0.5 ppm (cotton seed) % ADI = 9.36

to citrus with provisions for protecting workers from excessive exposure. The results of data on the remaining alternative miticides do not meet or exceed the risk criteria of 40 CFR 162.11.

E. RELATIVE ECOLOGICAL HAZARDS OF DICOFOL ALTERNATIVES

A synopsis of the ecological data base for the major alternative miticides is provided in Table II-29. None of the alternatives (for which data exist) is more chronically toxic, bioaccumulative, or persistent than dicofol and its DDTr contaminants.

Table II-29
Comparative Acute Toxicity of Dicofol and its Alternatives to Certain Non-target Organisms.

	Acute Toxicity[1]			
	Fish	Birds		Aquatic Inverts
Chemical	LC$_{50}$ (ppm)	LD$_{50}$ (mg/kg)	LC$_{50}$ (ppm)	LC$_{50}$ (ppm)
Dicofol	0.053	—	1237	0.65
Azodrin	5.2	4.7	2.4	0.3
Propargite	0.118	>4640	3401	0.09
Sulfur	>180	—	> 5620	> 100
M. Parathion	3.7	8.21	90	0.00014
Oxythioquinox	—	—	—	—
Fenbutatin-oxide	0.0017	> 2000	—	—
Cyhexatin	0.0037	300	195	0.00017
Ethion	0.210	45	> 5000	0.000056
Carbophenothion	0.013	121	320	0.0012
Chlorobenzilate	0.7	—	—	0.6
Methidathion	0.002	—	543	0.007
Monitor	25	10	42	0.026

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[1] Data are from EEB files and are for technical materials. References can be supplied upon request.

Table II-30
Comparative Chronic Toxicity and Fish Bioconcentration Factor[a] of Dicofol and some of its Alternatives to Certain Non-target Organisms.

	Chronic Toxicity[1] (ppm)		
Chemical/B[a]CF	Avian	Fish	Aquatic Invertebrates
Dicofol 3,700 ± 800	Mallard duck EL > 5	Fathead minnow 0.019 > MATC < 0.039	amphipod 0.019 > MATC < 0.039
DDT/DDE* 72,000	Black duck NEL < 0.6	Fathead minnow 0.0005 > MATC < 0.002	daphnia NEL < 0.00001
Methyl Parathion	Mallard duck EL > 15 Bobwhite quail EL > 15	Rainbow trout NEL < 0.08	daphnia 0.167 > MATC < 2.51
Cyhexatin	Bobwhite quail EL > 20	—	—
Monitor >2	Bobwhite quail 3 > NOEL < 5 Mallard duck EL > 715	—	—
Azodrin 1.3-2.8	Mallard duck EL > 3.0 Bobwhite quail EL > 1.0	—	—

1- Data are from EEB files and are for technical material. Reference can be supplied upon request.

F. ANALYSIS OF REBUTTAL COMMENTS

1. Comments on Exposure

Rohm and Haas has provided a statistical analysis (linear regression) of DDTr fish-residue data (National Pesticide Monitoring Program) with respect to temporal trends (1969-82) and trends related to dicofol sales in certain states. They conclude from their data that DDTr residues generally declined in the period 1967-81 in major dicofol use states. Also they report no general correlation of dicofol sales with DDTr fish residues. Overall, they conclude, "The data do not support the hypothesis of a correlation between use of dicofol and DDTr residues in fish."

Upon review of these arguments, the Agency concludes that Rohm & Haas has not rebutted Agency concerns over dicofol use contributing to DDTr residues in fish. This conclusion is based on the following findings.

(1) Correlation of DDTr in fish with dicofol sales data presumes fluctuations in use may result in corresponding changes in fish residues. This condition might occur only in very local high dicofol-use areas (e.g., such as the Arroyo Colorado drainage in south Texas where the Rohm and Haas analysis found residues had not significantly declined and a correlation between residues and dicofol sales exists [p.11]). It is unlikely that broadly scattered ambient residue monitoring stations such as are used in the NPMP would often include small areas where dicofol use controlled or dominated fish DDTr trends. In terms of broad trends in ambient DDTr residues, the Agency believes that prior use of DDT is likely the major contributor to past and present residues. Hence, it is understandable and expected that DDTr residues as measured by NPMP have, for the most part, declined in the interval 1969-82 and that they do not generally correlate with dicofol sales data. However, this decline and lack of correlation does not rebut the fact that dicofol will contribute significantly to DDTr loading in the environment.

(2) DDTr residues in the environment have likely resulted, in large measure, from past DDT use. Currently, new DDTr is added to the environment in small amounts relative to past use. New DDTr may come from global transport, dicofol and other sources such as illegal use. Elimination of the major source (DDT cancellation) has resulted in a dissipation of ambient residues followed by a period of slow decline or stabilization. The current sources become more important through time, and the general decline levels off when input to the system equals the residues lost from the system by transport or degradation. A key issue is whether dicofol use will cause local or regional residues to stabilize at levels that may be ecologically harmful. The Rohm and Haas rebuttal does not address this issue. It is significant that the most recently

published analysis of NPMP fish data (Schmitt et. al., 1983) notes that "Results for 1976-1979 continued to illustrate the effectiveness of the 1972 ban on the use of DDT in the United States. Residues of the most persistent DDT homolog (p,p'-DDE) declined after 1974, but appeared to stabilize by 1976-77."

2. Comments on Risk

The ecological toxicity of DDTr is firmly established and the registrant's rebuttal has not attempted to refute this. Pesticide registrants bear the burden of demonstrating the environmental safety of their registered uses. In this instance, because the toxic effects of DDTr are generally accepted, this may be done only by showing that dicofol will not significantly contribute to DDTr accumulations that are hazardous to the non-target organisms. This task is a considerable scientific undertaking because not only must environmental residues be described but also their long-term ecological effects delineated. The Rohm and Haas submission does not rebut any of the basic risk concerns.

3. Comments on Arroyo Colorado EXAMS Model

a. Comments Concerning Loading

Rohm and Haas submitted a report by Ketron, Inc. (Weeks, 1984) that commented on the EXAMS simulation of the Arroyo Colorado (Hitch and Reinert, 1983). Using different loading assumptions and alternative degradation parameters, Weeks' comments argue that the loading of DDTr to the Arroyo Colorado would be far less than the loading projected by Hitch and Reinert. Furthermore, the Weeks analysis assumed that the DDTr contamination of dicofol would be lower than the 10 percent value assumed by the Agency.

b. Agency Response

The substitution of alternative chemical dissipation rates does not appreciably alter the predicted water column concentration. The reported values of DDTr degradation found in the literature vary widely. Due to this variation, the Agency, in an unpublished sensitivity analysis, multiplied the degradation parameter values which had been selected by one hundred fold. The predicted water column concentration was not affected significantly.

Additionally, Weeks defends a smaller loading on the basis of assurances from Rohm and Haas that the average dicofol contamination level has recently been lowered. The Agency agrees, of course, that loading estimates should reflect product contamination levels which have been certified for each manufacturer. The Agency selected a ten percent contamination level. Fish residue levels can be prorated from any product contamination level that the registrants may submit. For example, Weeks used a contamination level of

6.5 percent, which would result in a fish residue of approximately 6.5 ppm. As discussed earlier, this level of dietary exposure has produced eggshell thinning (in the laboratory) and is expected to cause adverse reproductive effects in a number of avian species.

c. Comments Concerning Entrapment

Most Texas citrus farmers utilize flood irrigation. Water is pumped onto the fields and held in place by earthen dikes a few inches high. Weeks contends that these dikes are rarely destroyed and that they would trap DDTr-contaminated sediments and hold them on the field.

d. Agency Response

The Soil Conservation Service indicates that the Arroyo Colorado has been subject to massive flooding at intervals of approximately seven years. These floods destroy the retaining levees with the result that the fields have to be regraded. The DDTr compounds apparently persist to the extent that they would be available for sediment-borne transport during flooding for years after they have been applied. The half-life of DDTr in desert soils has been determined by Dr. George Ware at the University of Arizona to be about 12 years. In his rebuttal, Weeks presents data from a Mississippi Delta cotton study (Willis et al., 1983) showing that, for a study period lasting six years after the cessation of DDT use, the average annual runoff was 1.29 percent of the typical yearly application rate. At this time the weight of evidence indicates that DDTr will persist in the soils and be available for transport by periodic floodings.

e. Comments Concerning Settlement

Weeks utilizes sediment delivery ratios to estimate that 82 percent of the DDTr leaving the citrus fields would permanently settle out into the drainage canals before reaching the main stem of the Arroyo Colorado. This diminished loading estimate results partly from the entrapment of DDTr-laden sediments behind irrigation levees.

f. Agency Response

The Agency finds that Weeks' assumptions concerning the trapping of contaminated sediments in the drainage canals to be inadequately supported. Sediment delivery ratios are traditionally utilized to evaluate sediment entrapment on fields. Without specific information concerning the presence of catch basins, or other obstacles to lateral movement, one would assume that the amount of sediment entering the upstream end of an open channel will, eventually, exit downstream.

Further development of the "canal entrapment" theory could, at best, lead only to a geographic reassignment of loading (to the drainage canals) and development of the theory concerning mounded fields would most likely support only the assumption that loading would be small during a typical nonflood year. These canals, like the main stem Arroyo Colorado, may provide forage to sensitive wildlife, and, if the DDTr chemicals are retained on mounded fields during some years, they would presumably persist and accrue in the soil to be transported at unusually high rates during flood years.

4. Other Comments Received

Other comments were received from various user groups and agricultural extension agents. These comments were mostly testimonial in nature in that they described the crops and acreage treated and attested to dicofol's efficacy. No substantive information was submitted that the Agency could consider in its risk and benefits assessments.

Two environmental groups, the National Audubon Society and the Natural Resources Defense Council, responded that they support the Agency's initiation of the Special Review on dicofol.

The U.S. Department of Agriculture submitted a draft report to the Agency containing a survey of agricultural extension agents. This report contained information on the usage of dicofol as well as information on alternatives. The report was used in the development of the Agency's benefits analysis.

G. SUMMARY OF DICOFOL AND DDTr EFFECTS

Based on the data reviewed, the following conclusions were reached concerning the ecological risks posed by continued use of contaminated dicofol:

1. The miticide dicofol is contaminated with DDT, DDD, DDE, and Cl-DDT (DDTr). As indicated, a major concern has been with the conversion of DDT to DDE and subsequent reproductive effects in birds. Although the Agency does not have adequate information on the environmental fate of Cl-DDT, it assumes that this chemical is also a DDE precursor. Thus, use of dicofol products will inevitably result in release of DDTr into the environment with concomitant exposure of fish and wildlife.

2. DDTr contamination levels in dicofol are variable. Based on an estimated ten percent DDTr contamination level yearly use of two million pounds of dicofol would release 200,000 pounds of DDTr. Given the persistence of these contaminants, it is prudent to evaluate this pollutant-release over longer time periods. Thus, another decade of use at current rates and contaminant levels would indicate release of two million pounds of DDTr. In view of the toxic effects of DDTr, this is a significant and threatening amount of toxic material.

3. Immediate and long term wildlife exposure to DDTr will occur in areas where dicofol use is concentrated, e.g., citrus areas in Arizona, Texas and Florida, and on cotton in California and Arizona.

4. There is an association between major dicofol use areas and potentially hazardous levels of DDTr. Of particular concern are Hidalgo County, Texas and Maricopa County, Arizona where concentrated dicofol use (150,000 pounds per year and 70,000 pounds per year, respectively) is coincident with DDE levels among the highest in the nation. Evidence also exists showing ecologically significant DDTr residues in areas of heavy dicofol use in California and Florida. Actual contributions of dicofol to observed residues are not known.

5. Due to the mobility and persistence of DDTr compounds, use of dicofol will contribute to exposures remote from the site of application.

6. Though the majority of existing environmental residues of DDTr is likely the result of applications of DDT products, which ended in 1972, dicofol use would cause ambient DDE levels to dissipate at a slower rate and to stabilize at higher levels than if use were discontinued.

7. DDE residues are ubiquitous in fish in the United States. NPMP monitoring indicates that concentrations of the chemical declined immediately following the 1972 DDT cancellation, but may have stabilized by 1976-77 (Schmitt et

al., 1983). Concentrations in fish in many areas are near or within the range believed to cause reproductive effects in sensitive fish-eating bird species.

8. DDE residues are ubiquitous in birds in the United States. Recent NPMP surveys and other monitoring studies show that birds in many areas carry residues potentially harmful to themselves or birds that might prey upon them.

9. Species of endangered wildlife sensitive to DDTr inhabit regions where extensive dicofol use occurs. The Office of Endangered Species (OES) has determined that continued use of dicofol jeopardizes the continued existence of the American peregrine falcon and the Arctic peregrine falcon. OES recommmends cancellation of all dicofol uses for this reason. The OES biological opinion also found that continued use of dicofol may affect the brown pelican, wood stork, and bald eagle.

10. There is evidence that some bird species, such as California brown pelicans and bald eagles, once severely affected by eggshell thinning and associated problems are now in a period of subcritical effects. Some populations are recovering. Any measurable level of eggshell thinning or other evidence of DDTr-effects in wild populations would be ecological 'costs' that, in view of incomplete knowledge of long-term consequences, are considered potentially serious.

11. A preliminary avian feeding study with technical dicofol indicates that DDE tissue residues in exposed bobwhite birds exceed levels reasonably anticipated from product contamination.

12. Field studies conducted since 1980 have shown continuing DDE residues and eggshell thinning in American peregrine falcons, bald eagles, black-crowned night herons, black skimmers, and wood storks. Portions of studied bird populations were located in dicofol use areas. The great majority of bird species have not been studied.

In conclusion, the data reviewed indicate DDTr remains a hazard to wildlife in the United States. Moderate to high levels of DDTr exist in major dicofol use areas. Continued use of this pesticide will contribute to these high levels of DDTr and prolong these hazards to birds, fish, and other organisms.

III. BENEFIT SUMMARY FOR DICOFOL

A. Introduction

Dicofol (010501) is a chlorinated hydrocarbon miticide (acaricide) registered for use on a variety of agricultural crops as well as for home and garden uses to control a wide range of mite species. All registrant-submitted production and marketing data concerning this miticide are regarded as confidential business information. Recent OPP estimates indicate that 2.0-2.5 million pounds of dicofol active ingredient are applied annually to registered sites in the U.S. Registered dicofol usage site groupings include various small fruits, pome fruits, stone fruits, citrus, nut crops, vegetables, field crops, ornamental plants, turf grasses, greenhouse crops, house plants plus sites in and around domestic dwellings, and commercial and agricultural buildings.

Annual usage for dicofol fluctuates widely from year-to-year, since mite populations do not necessarily reach economic threshold levels requiring treatment of all crops or geographic areas every year. Usage estimates developed in 1980 and 1981, which are based on late 1970's data, indicate an annual usage estimate of approximately 2 million pounds active ingredient, with as much as ± 20% variation possible in any given year. Estimates based on more recent data for many sites, indicate an annual usage level ranging from 2.0-2.5 million pounds of dicofol active ingredient. Aside from unpredictable increases in mite populations, this increase may be partially explained by users deciding to apply dicofol in preference to alternatives. This switch may be due to use restrictions which were imposed as a result of regulatory action taken against chlorobenzilate or possibly due to mite resistance developed to one or more alternatives.

The benefit analysis for citrus uses of dicofol was prepared by both the Science Support Branch of the Benefits and Use Division, U.S.E.P.A. and a cooperative agreement between the Economic Analysis Branch and Arizona State University (Preliminary Benefit Analysis of Dicofol Use on Citrus, 1984). The benefit analysis for cotton use on dicofol and the remaining benefit reviews including the following site groupings: seed crops, stone fruits, pome fruits, hops, figs, vegetables, small fruits, tree nuts, mint, ornamental plants, turf grasses, and home and garden uses, were completed by the Benefits and Use Division.

The alternatives to dicofol were evaluated on the basis of their fit into the treatment schedule, guided by labeling statements such as the preharvest interval; pre- or post-harvest restrictions; number, timing, and frequency of application; reentry time; required safety equipment or restricted applicator use; and pests controlled on which sites. Other factors include comparative efficacy (degree of control), compatability in mixtures with other pesticides, phytotoxicity, local resistance limitations, affect on beneficials including pollinators (selective vs. broad spectrum pesticides), and efficacy vs. temperature. From these and other factors, significant benefits can be derived from the use of dicofol. These factors are not readily quantified in monetary terms. However, they do influence a growers selection of dicofol over other possible alternatives.

The economic impacts of using alternative miticides were estimated using partial budgeting and comparative cost evaluation in the case of cotton and citrus. This approach focuses on changes in control costs with alternative miticides while holding all other inputs and their costs constant for citrus. However, impacts on cotton production were further analyzed in terms of yield and quality effects.

Most of the economic impacts resulting from the cancellation of dicofol will be felt by cotton producers in the San Joaquin Valley of California. The total impacts experienced by U.S. cotton producers would range between $9.6 and $31.9 million in the short-term (one crop year), and between $11.0 and $37.1 million 1983 constant dollars annually in the longer-term. Economic impacts to citrus producers are expected to range from $3.5 to $4.0 million as a result of using more expensive alternatives to dicofol. Should there be yield and quality declines associated with the use of alternatives, impacts to citrus producers will be higher. Dicofol usage on cotton and citrus represents approximately 67 percent of all the active ingredient applied annually in the U.S.

The economic impacts relating to the cancellation of dicofol use on all minor use sites has not been quantified to date. However, it is estimated that production costs will increase from $1.1 to $1.4 million for producers of apples, nuts (principally pecans) and mint, solely as a result of using costlier alternatives. The remaining minor use sites are likely to realize some level of negative economic impacts, the magnitude of which is unknown at this time.

Insufficient data are available to allow EPA to determine the effects of a reduction in the number and type (e.g., organophosphate, organo-tin, chlorinated hydrocarbon) of effective miticides on pest resistance with the cancellation of dicofol. Increased usage of the remaining miticides could increase the potential for mite resistance to these chemicals by increasing the selective pressure on them. This could accelerate the development of resistance and shorten the life of the remaining materials. This and other benefits to IPM programs (e.g. reduction in number of pesticide applications, selective control) and being able to tailor pesticide recommendations to the existing circumstances of the season, crop and mite species, as outlined previously, can be critical to maintaining yield levels, and quality. There is no known method for nonchemical control (e.g. removing weed hosts, use of predators, and parasites) to reduce mite populations below economic thresholds. Normal sanitation practices, such as weed control in fields, along field margins, and beside irrigation ditches are carried out and at times have an effect, in suppressing but not controlling mite population development.

EPA recognizes that the following review does not address certain factors, in detail, which may affect the availability or usefulness of alternatives. These include a pesticide not being available (sold) in small packages, restricted use chemicals unavailable to homeowners, relative efficacy against species in a mite complex, mite resistance, labeling limitations, and relative cost effectiveness of dicofol vs. alternatives.

B. Cotton

U.S. cotton production in 1981 reached a record high of 15.6 million bales. Cotton producing acreage has tended to increase in the Southwest and decrease in the Southeast. Between 1971 and 1981 the western cotton production regions increased their share of U.S. cotton production from 44 to 73 percent, while increasing land area planted from 55 to 73 percent of the U.S. total. The major cotton production states are Texas, California, Arizona, and Mississippi.

Spider mites damage the cotton plant by sucking plant juices from the leaves, stems, and fruit. If not controlled, they can cause defoliation, loss of plant vigor, yield reduction (lint weight) and shortening of the staple length. High relative humidity and favorable plant growing conditions tend to be unfavorable to the development of mite populations. Periods of hot, dry weather, on the other hand, can trigger increases in mite populations which can cause economic loss. Spider mites generally occur in small numbers during the early part of the growing season in most cotton producing areas. An important exception to this is the San Joaquin Valley in California where cotton growers experience early mite outbreaks at economic levels almost every year. In this area, dicofol is considered to be the only available early season control for the strawberry spider mite,1/ a pest that can cause yield losses in infested portions of cotton fields of up to 35 percent, with field wide losses of up to 7 percent, common.

The two possible alternatives for this early season mite control use in the San Joaquin Valley, propargite and sulfur, must be ruled out because propargite is phytotoxic to young plants and sulfur is not effective against spider mites at temperatures below 95°F. Prolonged temperatures of 95°F+ generally do not occur during the early part of the growing season in the San Joaquin Valley. Midseason or later infestations of the Pacific spider mite and twospotted spider mite are controlled by applications of propargite or sulfur.

Estimates of the number of acre-treatments2/ typically made nationally with dicofol vary widely, ranging from 656.8 to 1,135.8 thousand per year. At an assumed dosage of 1.2 pounds of active ingredient per acre, the aforementioned values for acre-treatments implies an annual usage of dicofol ranging from approximately 0.8-1.4 million pounds. The San Joaquin Valley accounts for over four-fifths (85.0 percent) of all dicofol acre-treatments made to cotton, while the remainder of California, Arizona, the southeast, and Arkansas account for 4.0 percent, 9.2 percent, 1.4 percent, and 0.4 percent, respectively.

1/ The twospotted spider mite and, to a lesser extent, the Pacific spider mite can also build up at this time.

2/ A single acre may be treated more than once per season. Therefore, the total number of applications equals the number of acre treatments applied.

In order to evaluate fully the economic impacts of the cancellation of dicofol, an analysis was conducted with both a short and long-term perspective. The short-term represents a best estimate of the market conditions which will prevail in the cotton marketing season following the cancellation of dicofol (i.e., August 1, 1985-July 31, 1986). As such, the short-term estimate is based upon predicted (per an agricultural simulation model) values for acreages, yields, and prices, starting with the present and continuing through the second quarter of 1986. By contrast, the long-term estimate is timeless (i.e., not specific to any given year), in that acreages, yields, and prices (the latter in 1983 constant dollars) are based upon long-term averages of de-trended time series data. Moreover, in that the long-term estimate is cast in a comparative static framework, no allowance was made for acreage shifts due to changing yields, costs, and prices.

For the purposes of this analysis, it was assumed that in the absence of dicofol, current users in the Southeast U.S. and Mississippi Delta would switch to monocrotophos at no incremental cost, while those in Arizona and California outside of the San Joaquin Valley would switch to propargite, at an additional cost of $2.26 per acre-treatment. The aggregate increase in treatment costs would range from $1.2-2.2 million, amounts which hold for both the shortand long-term perspectives. These are only examples of the added costs that can occur, because other alternatives also exist. However, dicofol remains one of a small group of cotton miticides that are needed when IPM (integrated pest management) programs are implemented and a selective miticide is required. Most of the others are broad spectrum miticide/ insecticides. The cost of pesticide development works against production of new selective pesticides needed most in IPM.

In addition to incremental treatment costs, it is assumed that since growers in the San Joaquin Valley have no effective alternative to dicofol for early-season spider mite control, their crop would sustain a 3-5 percent loss in the quantity of lint, as well as some unknown reduction in quality relating to staple length and strength. In the short-term, this loss could range from $9.2-$29.7 million, depending upon the actual level of yield losses. In the long-term, losses to San Joaquin Valley growers could range from $10.7-$34.9 million 1983 constant dollars, again the precise amount depending upon the yield reduction experienced. In this regard, it should be noted that the yield-related impacts from cancellation are highly sensitive for California, due to the fact that lint yields there are approximately twice that of the national average.

When added treatment costs are combined with yield related losses, the total impact from cancellation sustained by all current users of dicofol could range from $9.6-$31.9 million in the short-term, and from $11.0-$37.9 million 1983 constant dollars annually in the long-term. In view of the fact that cotton prices are presently declining concurrently with an increased utilization of carry-over stocks, and given that the maximum projected loss of lint due to cancellation (approximately 85,000 bales, at 480 pounds per bale) would, at most, offset the rise projected between now and mid-1986 in the latter ratio, it can be concluded that the prices faced by the consumers of cotton products most likely would rise only slightly or not at all. Moreover, assuming an unchanged target price of $.81 per pound for 1985/86, and an average lint price of 63.2 cents per pound, the Federal Government would be able to reduce its budgetary outlay for deficiency payments to San Joaquin Valley growers by an amount ranging from $4.4-$7.3 million, the precise amount depending upon the yield losses sustained. It should be recognized that this amount represents neither a net welfare loss nor gain but rather a transfer of wealth from users of dicofol in the San Joaquin Valley via the Federal Government to all taxpayers.

In view of the foregoing considerations, it can be concluded that nearly all of the impacts of the cancellation of dicofol would be borne by San Joaquin Valley cotton producers who typically account for 10-12 percent of total U.S. cotton acreage or 20-25 percent of the production. While even the maximum impact shown above amounts to only about 1 percent of the total value of cotton produced annually (valued at farm-level prices), the average effect on San Joaquin Valley producers would be to increase their long-run average break even cost by 5.6 percent, from $.837 to $.884 per pound of lint. Given that the long-term average real price of cotton received by California growers is $.852 per pound, it can be seen that the cancellation of dicofol would most likely result in some portion of these producers being forced into the production of relatively less profitable crops than cotton. As noted above, this issue was not explored in the present analysis. However, it should be noted that even if a substantial shift out of cotton occurred in the San Joaquin Valley, the current national base acreage (in excess of 15 million acres) is at a level which would permit growers in other areas to fill the supply gap and still be in compliance with the current USDA cotton support programs.

C. Citrus

In 1977, dicofol was the fourth ranked citrus miticide (in treated acreage) accounting for 9% of the total acre-treatments with these chemicals. It was estimated at that time that there were approximately 260,000 acre-treatments of dicofol on citrus involving over 500,000 pounds a.i. (active ingredient) of dicofol. By 1980 the estimated usage of dicofol on citrus was 1.1 million pounds, indicating that usage had doubled between 1977 and 1980. This may be partially accounted for by regulatory restrictions imposed on the use of chlorobenzilate and yearly fluctuations in mite infestation levels.

Current usage estimates for dicofol on citrus indicate that approximately 587,000 pounds a.i. are being applied in 290,000 acre treatments in the major citrus producing states: Arizona, California, Florida and Texas. This marked decrease in the quantity of dicofol applied between 1980 and the present may be indicative of the variation in severity of mite infestations. The majority of dicofol use on citrus occurs in Florida, 73 percent by weight. Texas, California and Arizona account for 17, 8 and 2 percent respectively of the remaining citrus use of dicofol.

Mite infestations on citrus crops can reduce tree vigor and growth, thus reducing fruit quality and/or yield. Reduced profits may result from lower quality or lower yields caused by use of less efficacious alternative pesticides and/or from higher costs associated with the use of alternative pesticides. Citrus production is oriented toward either fresh fruit or processed fruit. Mites that affect fruit finish can be tolerated to a greater degree in fruit for processing than crops for the fresh fruit market. This can result in fewer control treatments for processing fruit. In general, it is thought that there would not be any significant citrus yield or quality reductions resulting from a shift to alternative miticides. Alternatives to dicofol are listed by state below.

Arizona	California	Florida	Texas
cyhexatin*	oxythioquinox	hexakis*	hexakis*
hexakis*	propargite*	chlorbenzilate*	ethion + oil
ethion	hexakis*	ethion	formetanate-hydrochloride
propargite*	cyhexatin*	propargite*	
		carbophenothion	

These alternatives are not necessarily as efficacious as dicofol for controlling all mite species in the various citrus-producing areas. Those with an asterisk (*) are selective acaricides, as is dicofol. The others are broad spectrum pesticides (miticide/insecticides). Additional review could better evaluate how these miticides fit into the various treatment programs in view of the preharvest interval, frequency of application allowed, phytotoxicity, restricted use, reentry limitations, mite complexes present, IPM needs, temperature limitations and/or compatability in spray mixtures.

There are eleven economically important mites and a number of less significant species attacking citrus in the U.S. Arizona, California, Florida and Texas and also individual regions within these states all have a unique primary mite complex plus those of secondary importance. The different species vary in the degree to which they attack the foliage, fruit, and/or new growth. These mites develop at varying times in the season, overlap with other species on the trees and are more easily controlled by one or more miticides than others.

All four states recommend dicofol. It is efficacious against a larger number of mite species than other miticides. Dicofol does not control the citrus bud mite, but is one of only two or three pesticides effective against the broad mite. Dicofol does not have temperature limitations or cause phytotoxicity problems, it is compatable with most pesticides in mixtures and is an unrestricted use pesticide with no reentry limitations. It fits well into IPM programs because it is relatively safe to most beneficial organisms unlike the broad spectrum miticide/insecticides. Mite resistance to dicofol has been minimal, over the years whereas many of the organophosphates and others have been rendered ineffective after a few years of use.

The minimum economic impact associated with the cancellation of dicofol use on citrus crops is expected to be between \$3.5 and \$4.0 million annually. This would be the result of using costlier alternatives to replace the current citrus uses of dicofol. The aggregate dollar impact of dicofol cancellation is expected to be less than 0.02 percent of the value of annual U.S. citrus production. Insofar as there are resulting yield and quality declines resulting from the shift to alternative controls, impacts will be higher.

D. Minor Uses

The following benefit reviews are brief evaluations of the importance of dicofol use as a miticide on minor use sites. These sites include: alfalfa and clover seed crops, caneberries, figs, grapes, hops, home and garden (non-commercial uses), mint, nuts, ornamental and turf (commercial uses), pome fruits, stone fruits, strawberries, and vegetables. These crops are attacked by many species of spider mites, eriophyid mites, and others. Crops vary in their susceptability to mites, and the importance of mites vary with the region and season. In general, spider mites are more likely to build up in mid to late season, during hot, dry years, and tend to damage stressed plants more than those growing under normal conditions. The state recommendations of selected states were reviewed, and the possible alternatives listed for the major mite pests of each crop. Other pesticides in registered products for use on these sites (U.S. EPA, PPIS)[3/] have not been reviewed. Little is known about the current levels of resistance of these mites to the miticides reviewed. There are more broad spectrum materials cited than selective miticides such as dicofol. As a result, the latter are more likely to be used as alternatives for dicofol.

The estimated losses presented in these benefit reviews represent only increased cost for treatment and control of mites using potential alternative pesticides and do not reflect additional impacts related to labeling limitations, chemical phytotoxicity of alternatives, other yield and quality effects, and losses due to the development of mite resistance to the remaining miticides. In general, the non-monetary benefits cited under citrus and cotton are applicable to these sites as well.

Alfalfa and Clover Seed Crops

Alfalfa is a perennial crop grown for seed throughout the U.S. but production is concentrated in the western states. The highest yields are realized in that area because growing conditions approach the ideal: moderately moist soil and low relative humidity along with warm, sunny weather and abundant pollinators during bloom and warm, dry weather to hasten ripening of the seed. Approximately 430 thousand acres of alfalfa

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[3/] PPIS = Pesticide Product Information System.

were harvested for seed in 1982. An estimated 40 percent of the alfalfa seed crop acreage and 80 percent of the seed production in the U.S. is located in California, Washington, Oregon, Nevada, and Idaho. Approximately 20 percent of that total alfalfa seed acreage is located in California.

Dicofol is used on alfalfa seed crops for control of spider mites (e.g. carmine, Pacific, strawberry, twospotted). Spider mite infestations in July can seriously reduce yields, but those occuring later in August usually do not. In Washington, overwintering spider mite populations can be reduced and controls minimized by applying dinitrochloro-IPC in April to control weeds. Various use estimates indicate that 30 to 40 thousand acres (7-9 percent of the U.S. total) of alfalfa grown for seed are treated with dicofol annually. Three probable alternative miticides are in state recommendations with propargite used most extensively. Formetanate-hydrochloride is also recommended, but it is not normally used to control spider mites because it has a prebloom restriction. Progargite and formetanate-hydrochloride are both more expensive per acre treatment than dicofol.

Clover is a perennial crop grown for seed throughout much of the United States. Clover is attacked by a complex of spider mite species similar to that on alfalfa. They are most likely to cause damage during hot, dry periods when the crop is under moisture stress. Nearly 320 thousand acres of all types of clover were grown for seed in 1979 with red clover being the most common variety. An estimated 35 percent of the U.S. clover seed acreage is located in California, Oregon, Washington and Idaho. As in the case of alfalfa, the growing conditions and abundant pollinators in these and other western states are conducive to high yields.

Available information indicates that very little clover grown for seed is treated with dicofol. It appears that dicofol is applied to an average of 1,000 acres (about .3 percent of the U.S. total) annually. Information was not available as to usage of the other recommended miticides, but propargite and oxydemeton-methyl are listed by USDA as providing satisfactory and fair levels of control, respectively. Demeton, mevinphos, and sulfur are also recommended.

Blackberries, Dewberries (Boysenberries and Loganberries) and Raspberries

The economic impact resulting from an immediate cancellation of dicofol usage on blackberries, raspberries, and dewberries (boysenberries, and loganberries) would generally be limited to minor grower level impacts localized primarily in Washington, and Oregon. Available information on usage is incomplete and subject to wide variation, but dicofol appears to be the pesticide of choice nationally. The major mite pests are the dryberry mite and several species of spider mites in the west and the spider mite species elsewhere.

It is estimated that dicofol usage on these sites is less than 10,000 lbs. a.i. annually. Since multiple applications may be necessary, total base acres treated would likely represent a small portion of the U.S. acreage. USDA (1984) indicates treatments on 325 acres with 100 more acres "treated occasionally."

If dicofol is unavailable, growers would most likely select oxydemeton-methyl for spider mite control. Its use is limited to one application per year; it has localized resistance problems, and a 48 hour reentry time. Cyhexatin, demeton, diazinon, mevinphos, and oxydemeton-methyl are listed in recommendations but have labeling restrictions that make them of limited use (e.g. post-harvest use only, pre or postbloom use). For dryberry mite control, lime sulphur appears to be the principal alternative to dicofol, but it is caustic and disagreeable to apply. Diazinon is toxic to bees and, therefore, cannot be applied during bloom. It also appears to have efficacy and resistance problems.

At present, comparative efficacy data are not available for dicofol and the other miticides; therefore, estimates of yield impacts could not be estimated. However, the other chemicals available have problems with efficacy, pest resistance and label restrictions which limit their usefulness, therefore, it can be expected that yield and quality will be reduced and production costs increased.

Hops

Approximately 78.6 million pounds of hops were grown on nearly 40 thousand acres in 1982. Hops are produced primarily in Washington with nearly 71 percent of the U.S. acreage and 74 percent of the total production. Hops are also produced in Oregon, Idaho and California. The total value of U.S. hops production in 1982 was approximately $138 million.

Hops are produced on long-lived, perennial vines, grown on trellises. The most common spider mite attacking hops is the twospotted spider mite. The Pacific spider mite and strawberry spider mite are also listed as pests of hops.

Dicofol is annually used on 3 to 4 thousand acres of hops to control spider mites. Several possible alternative miticides are available, including phorate, disyston, naled, cyhexatin, sulfur, parathion and methyl parathion. Dicofol falls approximately in the middle of the range estimated for total treatment costs on a per acre basis. Information on the extent of usage or effectiveness of alternatives was not evaluated.

Figs

About 99 percent of the U.S. fig acreage and production is located in California. Florida, South Carolina, and Texas are minor producers. Agricultural Census data (1978) indicate 16,879 acres of fig trees in the U.S. In 1982, fig production totaled 38.3 thousand tons with a value of $10.3 million (fresh basis).

At least three species of spider mites attack figs, but they are usually not a major pest problem for fig producers. Dicofol is registered for use on figs to control spider mites, but it is seldom used and it has had resistance problems in the past. Propargite is the material of choice, because of superior efficacy and fitting into the IPM program better, even though it is somewhat more expensive per acre than dicofol. Carbophenothion is considerably less expensive on a per acre basis than either miticide, but it is a broad spectrum material and has resistance problems. Another possible alternative is superior oil but it is of limited use and effectiveness.

Strawberries

An estimated 39,450 acres of strawberries valued at about $422 million were harvested in the U.S. during 1982. California produced over 70 percent of the crop on about 28 percent of the U.S. strawberry acreage. Other states with significant commercial production include: Florida, Oregon, Washington, Michigan, North Carolina, New Jersey, New York, Ohio, Pennsylvania and Wisconsin. The remaining states have some strawberry oduction for either home, market garden or pick-your-own operations.

Dicofol is used to control spider mites on at least 3,000-6,000 acres of commercial strawberries. An additional unknown quantity of home and pick-your-own acreage is also treated, but this could not be estimated with available data. The total quantity of dicofol usage on strawberries is probably less than 10,000 lbs. a.i. annually.

Only carbophenothion, cyhexatin, and propargite of the eleven chemicals registered for use on strawberries against the numerous species of spider mites are considered to be suitable alternatives. However, cyhexatin and propargite are phytotoxic to some strawberry varieties and this has resulted in yield losses of up to 20 percent. Carbophenothion is not a choice in an IPM program, because of its affect on beneficial organisms. Resistance to it in the Pacific Northwest is a localized problem. Five others appear to be possible alternatives to dicofol under limited conditions: demeton, ethion, hexakis, oxydemeton-methyl, and propargite. Comparative performance data for these chemicals are not available. Current data suggest that efficacy, label restrictions and cost will combine to increase mite control costs in infested areas. In the aggregate, a cancellation of dicofol on strawberries is not expected to have severe economic effects at the regional or national levels. This conclusion is supported by the relatively minor extent of usage and the availability of other chemicals.

Ornamentals and Turf (commercial)

In 1978, dicofol sales amounted to an estimated 30% of the total sales value of miticides used on ornamentals. Since then, dicofol usage has been increasing steadily. The probable current usage exceeds the 30% market share noted above.

Estimates of usage of dicofol on ornamentals is 270 thousand pounds a.i. per year. This represents 9.7% of total dicofol usage. Turf usage only represents 2.9% of total dicofol usage or 80 thousand pounds a.i. In a report prepared under contract to EPA, 1981, national usage of dicofol by Pest Control Operators in the urban environment was estimated at about 29,000 to 39,000 a.i. lbs.

There are scores of ornamentals and many more species of mites that attack them than for any agricultural crop. Dicofol usage is nationwide. The number of miticides that can be used overall probably exceeds the 32 listed by USDA, 1984, but for any given site/pest situation the possible alternatives can be very limiting. An analysis of this complex group of sites will entail considerable review.

State recommendations for use of dicofol and registered alternatives on lawns, turf and ornamentals are presented in a USDA survey of state extension entomologists (USDA, 1984). Of the alternatives listed in a USDA report, generated from the aforementioned survey, for use on ornamentals, only dimethoate is recommended as having satisfactory performance without being too restrictive or too expensive. No alternatives were recommended for dicofol use on lawns.

The need to control mites on the different turf grasses varies throughout the U.S. Florida recommends diazinon for Bermudagrass mite control. California lists dicofol and diazinon against spider mites and eriophyid mites, and Ohio and West Virginia list dicofol, diazinon and chlorphyrifos for clover mite control. Only dicofol is a selective miticide. Georgia, Illinois, Indiana, Louisiana, Maryland, New York, North Carolina, and Washington did not cite mites on turf as a problem in their recommendations. Other miticides in registered products for use on turf have yet to be evaluated.

A qualitative assessment of the impact of cancellation of dicofol indicates that there would probably be a significant impact on both commercial ornamental and turf sites, since alternatives do not appear to be fully satisfactory from a cost, efficacy, toxicity or non-target organism perspective.

Mint (peppermint and spearmint)

The 1983 USDA Agricultural Statistics (USDA, 1983) indicates that peppermint is a commercial crop in Idaho, Indiana, Oregon, Washington and Wisconsin, and spearmint is commercially grown in Idaho, Indiana, Michigan, Oregon, Washington and Wisconsin. In 1981, the Pacific Northwestern states produced 86 percent (Idaho 488,000 lbs.; Oregon 2,470,000 lbs.; and Washington 647,000 lbs.) of the total U.S. peppermint oil and 82 percent (Idaho 177,000 lbs.; Oregon 150,000 lbs.; and Washington 1,459,000 lbs.) of the total U.S. spearmint oil. The remaining mint oil is produced in the Midwest.

Mint is a perennial crop that requires a 15 hour day length for maturation and maximum oil production. It, therefore, cannot be grown commercially below the 41st parallel.

Dicofol is registered for control of the twospotted spider mite on mint (peppermint and spearmint). Heavy infestations of the strawberry spider mite and the twospotted spider mite can result in decreased quality and yield of mint oil. In the Midwest, mites are not a significant problem on mint. The weather conditions in the Midwest, the fact it is grown on muck soil, and that growers irrigate regularly prevent serious mite problems. Occasionally, during unusually high temperatures and/or dry weather conditions sporadic mite infestations occur. Spider mite problems occur frequently on mint grown in the Pacific Northwest, and dicofol is the primary miticide used there. If a mite problem should occur on mint in the Midwest, dicofol is the miticide most frequently recommended. Approximately 12,000-20,000 pounds a.i. of dicofol are applied annually to an estimated 10,000-18,000 acres of mint in the Pacific Northwest. The amount applied and the number of acres treated fluctuates dramatically from year to year depending on the severity of the spider mite problem. There has been little or no dicofol applied to mint crops in the Midwest during the last two or three years.

Propargite is the most likely alternative to be used in the Pacific Northwest if dicofol is cancelled. Propargite is effective and is currently used alternately with dicofol. Dicofol has a longer residual effect than propargite and controls mites more quickly. Growers alternate these chemicals to prevent mites from developing resistance to either pesticide. Dicofol is applied if mites occur early in the season. If mites occur or re-occur later in the season, propargite is usually applied.

Oxydemeton-methyl is registered for control of the twospotted spider mite on mint in the Midwest, but is only registered for the strawberry spider mite on mint in the Pacific Northwest. Oxydemeton-methyl has a shorter residual effect than dicofol and often requires two applications. Depending on the time interval, late applications of oxydemeton-methyl can cause phytotoxicity.

Cancellation of dicofol for control of the spider mites on mint could cause short-run economic hardship to some growers in the Pacific Northwest due to higher pesticide costs. In Idaho, the product cost of dicofol ranges from $8.50-$12.75 per acre while propargite ranges from $14.50-$26.60 per acre (USDA, 1984). Similar cost differences would be expected in Oregon and Washington. Based on the estimated treated area, total production costs would increase by as much as $250,000 annually. Economic losses may also result from decreased yields in the early season caused by spider mite damage that occurs in the time it takes propargite to take effect. Certain growers may adjust by growing a different crop (most likely wheat in the Pacific Northwest), in order to reduce economic losses. Mint growers are concerned that continued use of propargite alone will lead to the development of resistance by mites. Propargite and dicofol appear to be the only effective miticides currently available for mite control on mint.

Home and Garden (non-commercial)

Dicofol is the most widely used miticide on home and garden sites. The home and garden sites include various vegetables, small fruits, pome fruits, stone fruits, citrus, tree nuts, ornamental plants (trees, shrubs, annual and perennial bedding plants, and greenhouse and house plants). Dicofol is registered to control many mite species; all of which can cause aesthetic, as well as yield losses. EPA estimates that roughly 60,000-80,000 pounds a.i. of dicofol are used on home and farm sites annually.

There are other chemicals registered for control of mites on home and garden sites: for instance, chlorpyrifos, diazinon, dimethoate, disulfoton, endosulfan, malathion, oil, oxydemeton-methyl, and sulfur. There are many more mite species on the array of ornamental plants than on any agronomic crop or group of crops. No acaricide can be considered a replacement for all uses of dicofol. Dimethoate is one of the more efficacious alternatives, but it requires protective clothing to use which makes it of limited suitability to the homeowner. Others have a very limited spectrum of activity on mite species and some other miticides tend to suppress mite populations rather than control them thereby requiring repeated applications. USDA indicates that users are concerned with or limited by toxicity, formulation, package size and types, non-target pest problems (destroying beneficial insects), phytotoxicity, resistance, restricted uses and expense with respect to the alternatives. Most importantly, no one chemical appears to have as broad a spectrum of control as dicofol in terms of the number of species of mites controlled on as wide a variety of sites. Gardeners are not often aware of what pesticide controls an individual species of mite nor are they able to identify them. Therefore, they prefer an all-purpose miticide like dicofol.

Cancellation of dicofol will result in increased control costs for home and garden sites, because the alternatives are slightly more expensive. Costs will also increase since users will likely purchase more than one pesticide depending on the specific mite problem they face and/or the site they are trying to treat. Some users may be reluctant to cope with the problem. This could result in monetary losses in the form of the replacement costs of damaged plants and shrubs, or the market value of lost produce from vegetable gardens. The most important factor to the homegardener is the pleasure of having fresh, quality produce and/or aesthetically pleasing, healthy, decorative gardens and cut flowers.

Nuts

Dicofol is registered for the control of several species of mites on chestnuts, filberts, hickory nuts, pecans and walnuts. There are several spider mites that feed on chestnuts in the U.S. where production is very limited. USDA recommends dicofol, ethion, or malathion against them. Filberts are grown primarily in Oregon. Dicofol is the only miticide recommended for control of the occasional outbreak of spider mite species. The filbert bud mite is not effectively controlled by dicofol. Data are not readily available on the limited U.S. commercial hickory nut production. English walnuts are attacked by the walnut blister mite and several species of spider mites. California is the principal U.S. producer of walnuts. In addition to dicofol; carbophenothion, phosalone, and propargite are in products registered for use against spider mites on walnuts. Other possibilities are ethion or dioxathion, but propargite is the material of choice against spider mites on this crop.

The only nut crop where there appears to be any significant dicofol usage is on pecans. Pecans are primarily grown in the Southeast (Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina) and the Southwest (Arkansas, New Mexico, Oklahoma, Texas). Mites are seldom a problem on pecans in the Southwest, but sporadic mite outbreaks do cause economic losses in the Southeast.

There are several species of spider mites that can attack pecans including the pecan leaf scorch mite. Heavy populations, of this mite, cause defoliation from the lower branches upward. Defoliation results in failure of the trees to bloom well the next spring, followed by a poor nut crop.

Approximately 50,000-75,000 pounds a.i. of dicofol are used annually on 10-17 percent of the pecan acreage in the Southeast (primarily Alabama, Florida, Georgia, and South Carolina).

In addition to dicofol, USDA recommends the following chemicals for the control of mites on pecans: aldicarb (Southeast only), azinphos-methyl, calcium polysulfide, carbophenothion, demeton, diazinon, dimethoate, EPN, ethion, parathion, malathion, and sulfur (USDA, 1982). Dicofol and hexakis are the primary miticides used on pecans in Georgia and Alabama. Overall dicofol is more effective, and it is faster acting than hexakis. As a last resort, Alabama growers will use demeton and carbophenothion. Dimethoate was the primary miticide used on pecans in Louisiana until last spring. However, mites have begun to develop resistance to dimethoate, and growers have switched to dicofol and to some extent hexakis. In addition, there has also been some use of wettable sulfur in Louisiana.

Hexakis is the most likely alternative to replace dicofol. However, growers in the Southeast appear to have little confidence in the alternative or are reluctant to pay the higher prices entailed. The per acre chemical cost of hexakis is $17.00-$17.50 compared to $12-$15 per acre for dicofol. Substituting hexakis for dicofol would increase production costs of pecans $2.00-$5.50 per acre. Total production cost of dicofol treated acreage in the Southeast could increase as much as $260,000 annually.

Vegetable Crops

Dicofol is registered for use on a number of vegetables for control of mites. The major use sites are beans (snap, lima, succulent, and dry), eggplant, melons, peppers, cucumbers, squash, and tomatoes). Dicofol is used to treat 4 percent of the bean acreage, 5 percent of the eggplant acreage, 14 percent of the melon acreage, up to 3 percent of the pepper acreage, about 1 percent of tomato acreage and up to 10 percent of the cucumber and squash acreage.

The principal mite pests of vegetables are the spider mites, including the carmine, desert, Pacific, sixspotted, strawberry, tumid and twospotted spider mite. Their importance varies with the mite species, distribution in relation to where the crop is grown, their biology, host range, and many efficacy and resistance factors. Spider mites are primarily foliage feeders that reduce plant vigor and yield. In addition to spider mites, the tomato is attacked by the foliage feeding tomato russet mite which can cause defoliation and loss of grade, when exposure causes sunscald on the fruit. Spider mites tend to be sporadic problems on vegetables. Usage figures are low compared to major crops with serious mite problems, however, when outbreaks occur, control is necessary.

The following is the estimated annual U.S. dicofol use on vegetables.

Site	Acres planted	Acres treated	Pounds applied (a.i.)
	1,000		
beans	1,916.5	80	65
cucumber & squash	198.8	1 to 20	1 to 20
eggplant	5.9	0.3	0.5
melons	330.0	45	40
peppers	63.9	2	3
tomatoes	396.5	4	16

Preliminary indications are that a number of possible alternative materials are available and used for mite control. Dicofol has the advantages of being lower in cost, having a longer residual activity than primary alternative materials and is one of the few miticides without broad spectrum activity.

A review of the states which consider these vegetable crops important and provide recommendations, indicates that dicofol is generally listed alone or with several other pesticides to control spider mites and/or the tomato russet mite depending upon the crop. As with other crops, various limitations and considerations such as phytotoxicity, preharvest interval, toxicity level to applicators, pest spectrum present, and costs are important in determining whether there are any or several alternatives available for a given set of circumstances.

The following list gives a brief overview of the state recommendations for mites:

Crop	States that List Mites as a Pest	States that Recommend Dicofol	Dicofol Listed Alone	Number of Other Pesticides Listed by States
beans	4 of 5	3	—	12
cucumbers	11 of 13	10	—	11
eggplant	9 of 11	3	—	10
melons	12 of 14	12	—	13
peppers	8 of 19	8	—	6
pumpkins	7 of 9	6	2	5
tomatoes	14 of 17	14	—	11
squash	7 of 11	7	3	7

All the pesticides tabulated above, other than dicofol and sulfur on beans, are broad spectrum materials. No information has been reviewed to attempt to categorize the resistance picture for miticides used on vegetables.

Comments submitted to EPA by USDA indicate that chlorpyrifos, diazinon, and malathion are not as effective as dicofol on all crops listed. Carbophenothin, ethion, naled, parathion, oxydemeton-methyl, and sulfur were not as effective on one or more of the crops listed.

The possible alternatives to dicofol appear to include: (1) beans - carbophenothion, demeton, endosulfan, and oxydemeton-methyl; (2) cucumbers - dimethoate, carbophenothion; (3) eggplant - carbophenothion and demeton; (4) melons - carbophenothion and demeton; (5) peppers - carbophenothion and demeton; (6) pumpkin - carbophenothion and dimethoate; (7) tomatoes - carbophenothion and demeton; and (8) squash - carbophenothion and dimethoate. None of the alternatives are selective miticides and their use would result in problems for IPM programs.

The information available indicates that the overall loss of dicofol use on vegetables would not create serious problems for the producer. Those producers currently using dicofol would have increased production costs due to the higher cost of alternative materials and an increased number of chemical applications for satisfactory mite control.

Grapes

Commercial grape production is concentrated in California with 93% followed by Washington and New York with 2.4% each. Other states producing grapes commercially include Michigan, Pennsylvania, Arizona, Arkansas, Ohio, North Carolina, Georgia, Missouri, and South Carolina. The three grape species grown are Vitus vinifera (mostly west coast), Vitus labrusca (concentrated in the northeast) and Vitus rotundifolia (in the south). Although there is a grape bud mite, grape erineum mite and grape rust mite, the major mite pests of grape are the spider mites (four principal species), against which most of the miticide use is directed.

In all, about 30,000 to 50,000 of the 762,500 acres of U.S. grapes are treated with dicofol. Each area has unique mite problems: California has the Pacific spider mite and twospotted spider mite; Washington, the McDaniel spider mite; and the Northeast has the twospotted spider mite and European red mite.

Of the nine pesticides listed in state recommendations for use against spider mites on grape, hexakis and propargite are the primary alternatives to dicofol. Dimethoate and phosalone may also be useful. The five remaining active ingredients plus several others listed by NPIAP (USDA) or the PPIS listing appear to have major limitations when compared to dicofol.

The major usage area for dicofol against spider mites is in New York. Additional indications are that propargite is preferred for mite control under the growing conditions in California and Washington. Dicofol, dimethoate and hexakis appear to be the next most desirable. In the northeast, dicofol is preferred with hexakis and phosalone as the best alternatives. Dicofol appears to be preferred when spider mites are the only significant problem and the grower needs a material with residual action. Growers who have spider mite problems in conjunction with insect pests would probably utilize a broader spectrum material to control the pest complex (e.g. carbophenothion, dimethoate, ethion, phosalone).

A preliminary examination of the loss of dicofol indicates that severe financial impacts to grape growers are not expected. The shift to alternative materials would result in the use of more expensive controls and having to apply these materials more frequently, since the alternatives have limited residual activity. More review is necessary to compare the possible alternatives to the various field conditions and pest populations, at least in the major grape production areas.

Pome Fruits

Dicofol is registered for control of apple rust mite on apples and spider mites on apples, pears, quinces, and crabapples. The principal spider mite species on pome fruits include the following: brown mite, European red mite, McDaniel spider mite, Pacific spider mite, Schoene spider mite, twospotted spider mite, Willamette spider mite, and yellow spider mite.

Among pome fruits, apples represent by far the most important use of dicofol, with pears a distant second. No acreage or dicofol usage data on quinces and crabapples were found, therefore, only apples and pears will be considered in the following analysis.

Apples

While apples are grown throughout the continental United States, the USDA routinely reports production statistics for only thirty-five states. In terms of volume, however, apple production is geographically concentrated. The three leading states, Washington, New York, Michigan, ranked in descending order of importance, accounted for approximately 60 percent of total apple production in 1983.

Dicofol is used against the apple rust mite and the spider mite complex which varies with the state or region and the season. There are at least eight spider mite species that can be a pest problem, each with its own biology, behavior and response to chemical control.

The correlation of labeling restrictions, the pest complex, and field conditions to the possible alternatives for dicofol are critical. In the evaluation process, we must consider the well established apple IPM programs, utilizing the limited number of selective miticides as opposed to the broad spectrum materials is an important consideration. The dormant/delayed dormant oil application is important to any mite control program on apples. However, oil only controls those mites overwintering on the host (e.g. European red mite) and not those that overwinter on cover crops, etc. (e.g. twospotted spider mite). Rotation of miticides among their various classes (e.g. organophosphate, organo-tin, chlorinated hydrocarbon) is necessary to slow the development of resistance to any one or all of them.

Dicofol fits well into early season spider mite control programs because it is relatively safe to most beneficial insects. Though moderately to highly toxic to the predatory mite Amblyseius fallacis, dicofol has minimal impact if applied early because these overwintering mites don't start moving up the tree until early spring through the post-bloom stage. Late season applications of dicofol can disrupt the predatory mite populations and cause a resurgence of spider mite populations. However, because of its quick action and residual effects, dicofol is recommended in IPM programs when other miticides and predatory mites have failed to keep spider mites below economic threshold levels.

Among the registered alternatives to dicofol, the most widely used is cyhexatin. Recently, dicofol has been gaining in the market share relative to cyhexatin, due to the observations of growers and extension experts that mites have become resistant to the latter chemical, especially in the State of New York. The best available estimate of current annual dicofol usage on apples nationally ranges from 120,000-180,000 pounds of active ingredient or 40,000-60,000 treated acres. This estimate assumes an average of two applications per season at a rate of 1.5 pounds a.i. per acre. Although the foregoing estimate of acres treated is substantially less than that suggested by USDA, it is consistent with industry submitted sources.

Should dicofol be cancelled for use on apples, the resulting impact would be an increase in annual production costs, ranging from $0.6-0.9 million. This estimate assumes that the alternative miticides; cyhexatin, propargite, and formetanate-hydrochloride would afford a level of control equivalent to that of dicofol. While it has been widely stated that various species of mites have become resistant to cyhexatin, it is also generally acknowledged that apple growers have encountered similar problems with dicofol, propargite and hexakis.

Given that the increased production costs cited are miniscule in comparison to the total farm-gate value of apple production (approximately $850 million in 1983), it is unlikely that the cancellation of dicofol would result in a reduction of the national supply of either fresh or processing apples; and as a corollary, consumer prices (excepting for possible localized fresh-market situations) would be unaffected. For those growers currently using dicofol, however, the impact of cancellation on a per-acre basis, estimated at approximately $14, might contribute to a per-acre net revenue loss as high as 3-5 percent. Because dicofol usage has recently increased significantly in New York, it would be reasonable to conclude that a substantial portion of the $0.6-0.9 million cost increase cited above would be borne by producers of that state.

Pears

While the 1978 Census of Agriculture reports pear production in nearly all of the forty-eight continental states, roughly 95 percent of the total 1983 crop was produced in the three states of Washington, California and Oregon, ranked in descending order of importance. According to USDA, over 7,000 acres of pears are treated with dicofol, but only in Minnesota, New York, and Oklahoma. By contrast, an industry source reported that less than 1,000 acres were treated in 1979. The same industry source, while updating its apple estimate to 1983, felt it unnecessary to do so for pears. Other data sources indicate that dicofol is used only sporadically on pears.

Mites become abundant in dry, hot weather. Pear orchards that are not irrigated are most likely to be affected. The five most common plant feeding species of mites found on pears are the European red mite, twospotted spider mite, pear rust mite, McDaniel spider mite (Washington) and the pear leaf blister mite. The latter species is not controlled by dicofol.

Mites on pears should be controlled because low numbers of mites can cause foliage injury and the pear rust mite and the pear leaf blister mite cause direct fruit damage.

Dicofol is used on pears, albeit only minimally. With the information presently available, it is impossible to determine whether this dicofol usage reflects a price advantage, a superior mode of action, or both in certain localized situations. Overall, the impact from the cancellation of dicofol would have only negligible impacts on pear supplies and prices.

Stone Fruits

Dicofol is registered for the control of mites on the following stone fruits: apricots, cherries, peaches/nectarines, and plums/prunes. USDA has reported that approximately 91,000 pounds of active ingredient are used to treat about 51,000 acres. As was the case with pears, this estimate greatly exceeds those from industry sources. The Agency has estimated the combined total usage of dicofol on peaches/nectarines and cherries to be approximately 6-7 thousand acre-treatments, accounting for 9-14 thousand pounds of active ingredient. Use of dicofol on plums/prunes would appear to be negligible, presumably reflecting the fact that mites are not a serious problem on this crop.

Based on the fact that dicofol accounts for only a small percentage of the miticides used on peaches/nectarines, it can be concluded that its cancellation would have relatively little impact on either producers or consumers. On the other hand, dicofol accounts for a significant share of cherry miticide market. Cancellation of dicofol use on this site might result in market impacts.

Apricots

Although apricots are grown widely throughout the United States, virtually all commercial production occurs in Utah, Washington and California with the latter accounting for approximately 97 percent of U.S. production. Data from California indicate that less than 40 pounds a.i. of dicofol were used on apricots in 1982. No other usage information on this site is currently available.

At least eight species of spider mites (e.g. European red mite, twospotted spider mite) and two eriophyid mites (peach silver mite, plum rust mite) attack apricots.

Feeding of the eriophyid species can affect the vigor of the trees, and cause silvering of foliage, defoliation and reduction of fruit size and quality. The spider mites affect plant vigor by extracting plant juices and yellowing foliage, reducing fruit size and quality.

Possible alternatives to dicofol include propargite and endosulfan for the peach silver mite and plum rust mite. For spider mite control, propargite, and cyhexatin are the alternative selective miticides listed. The broad spectrum pesticides include phosalone, azinophos-methyl, demeton, ethion, methiocarb, and oil.

Cherries (sweet and tart)

Major states for sweet cherry production (79 percent combined) include Washington, Oregon, California, and Michigan in descending order. Michigan produces over 75 percent of the tart cherries followed by New York with 9 percent.

Mites attacking cherries include the: brown mite, European red mite, McDaniel spider mite, Pacific spider mite, Schoene spider mite, twospotted spider mite, Willamette spider mite and yellow spider mite. The eriophyid mites include the cherry rust mite, peach silver mite and plum rust mite. Effect on the trees are similar to that on apricots. The cherry rust mite bronzes foliage, but is generally not a problem in bearing orchards.

Dicofol accounts for a significant share of the acaricides applied to cherries. This cancellation might result in market impacts for cherries.

Possible alternatives for spider mite control in the Northwest, as specified in the USDA handbook include: hexakis and propargite among the selective acaracides and azinphos-methyl, oil, methiocarb, parathion and ethion from the broad spectrum pesticides. Recent California recommendations were unavailable. Fruit specialists in Michigan feel that there is no suitable alternative for dicofol. New York lists carbophenothion, malathion and parathion along with dicofol for a post-harvest application. For the plum rust mite, only endosulfan is recommended.

Nectarines/Peaches

Peaches are produced commercially in about two-thirds of the states. However, California produces almost all of the clingstone and 30% of the freestone varieties, followed by South Caroline (23%), Georgia (9%), New Jersey (6.5), and Pennsylvania (6%).

Virtually all the commercially produced nectarines are produced in California. Nectarine production is about 1/30th of that for peaches.

The spider mite species and eriophyid mites attacking peaches and nectarines are generally the same as those on apricots and cherries, except for the cherry rust mite.

Dicofol is one of the principal miticides applied to peaches. Data on nectarines is lacking. The recommended selective miticides which are possible alternatives to dicofol include cyhexatin, hexakis, formetanate-hydrochloride, and propargite. The broad spectrum materials include oil, carbophenothion, azinphos-methyl, malathion, mesurol, methiocarb, oxydematon-methyl, demeton, ethion, endosulfan, and phosalone. Most of these are also contained in products registered for use on nectarines.

Plums/Prunes

California is the principal grower of plums with production about twice that of Oregon, Washington, Michigan and Idaho which produce appreciable amounts of prunes and plums combined. Of the approximately 60,000 tons grown annually in those four states, production on a percentage basis is Oregon (48%), Washington (23%), Michigan (18%) and Idaho (10.5%).

There are at least six spider mite species (brown mite, European red mite, McDaniel spider mite, Pacific spider mite, Schoene spider mite and twospotted spider mite as well as two eriophyid mites (the peach silver mite and plum rust mite) which are pests on plums. Plum rust mites can cause leafrolling and fruit russeting. Spider mites cause yellowing of the foliage and together they can reduce tree vigor and therefore fruit size and quality.

For plum rust mite, endosulfan, wettable sulfur and hexakis are possible alternatives. Alternatives for spider mite control include: propargite, ethion, hexakis, cyhexatin, oil, azinphos-methyl, demeton, and parathion.

IV. DEVELOPMENT OF REGULATORY OPTIONS

A. INTRODUCTION

As previously explained, FIFRA mandates the Agency to weigh the risks against the benefits for the uses of a pesticide in order to determine whether continued registration would cause unreasonable adverse effects on the environment. In Chapters II and III, the risks posed by exposure to dicofol and the benefits derived from its registered uses have been discussed. To determine whether continued registration of dicofol is appropriate, the Agency has identified a number of regulatory options, and has evaluated each option for its impacts on both sides of the risk/benefit equation.

In addition, the Agency has identified available alternative pesticides for the various uses of dicofol. The general risks of alternative pesticides have been evaluated based on the available data.

This section identifies the regulatory options available to the Agency to reduce the risks from the registered uses of dicofol. The legal basis for these options is also discussed and each option will be evaluated for its impact on the risks and benefits of the registered uses of dicofol; then the most appropriate regulatory option is selected.

B. LEGAL BASIS FOR OPTIONS

FIFRA provides the Agency with three legal courses of action concerning a registered pesticide. These are suspension/cancellation, continued registration with no restrictions, or amendment of the terms and conditions of registration.

To make a determination as to which course of action is appropriate, the Agency weighs the risks and benefits of the uses of a pesticide. If the risks of use outweigh the benefits, and the risks cannot be lowered, registration may be cancelled. In the case of cancellation, the Agency issues a notice of intent to cancel the registrations of a pesticide [FIFRA, section 6(b)(1)]. Such a cancellation notice becomes effective automatically 30 days after publication or receipt by the affected registrants, unless a registrant or other adversely affected party requests a hearing regarding the cancellation.

If the benefits of continued use outweigh the risks and any actions taken to reduce the risk result in a significant reduction in benefits, the registration of that use may continue with no restrictions. In the case of continued registration without restrictions for a chemical which was initially identified as a potential cause of unreasonable adverse effects and subjected to Special Review, the Agency may publish a final Special Review document (PD 4) stating a rationale for choosing that course of action.

A wide range of possible regulatory actions exists for cases when the risks exceed the benefits or when the benefits are greater than the risks, and the reduction in risk would not result in a significant reduction in benefits. FIFRA requires the Agency to "consider restricting a pesticide's use or uses as an alternative to cancellation..." [FIFRA Secion 6(b)]. Although FIFRA does not specify what kinds of restrictions are to be examined, the Agency interprets this to mean amending the terms and conditions of registration in any fashion necessary to lower risks without counterbalancing reduction in benefits.

C. DATA GATHERING FOR IDENTIFICATION OF OPTIONS

In the process of varying the terms and conditions of registration, the Agency can investigate many regulatory options. In order to facilitate the development of viable regulatory options, FIFRA provides the Agency with certain legal mechanisms to be used in the process of gathering information on available options. The legal mechanisms which FIFRA provides are:

1. Additional Data

Under FIFRA section 3(c)(2)(B), the Agency may require a registrant to submit any additional data necessary to maintain an existing registration. When conducting a special review of a pesticide, the Agency may identify areas in its risk and benefit analyses where data are inadequate or lacking. The Agency may then require a registrant to provide specific data within a certain time. If the registrant fails to comply, his registrations may be suspended. If the newly submitted data justify doing so, the appropriate regulatory course of action can be reconsidered.

2. Information-Gathering Hearings

If the Agency is uncertain whether to cancel or restrict a pesticide, he may publish a notice of intent to hold a formal hearing to resolve the issue [FIFRA section 6(b)(2)]. At the end of the hearing, the Agency makes a decision based on the hearing record. As an alternative to a formal hearing, the Agency may conduct an informal hearing to gather information [FIFRA section 21(b)] and then use that information to propose a recommended decision.

D. LEGAL OPTIONS AVAILABLE UNDER FIFRA

The following regulatory options are available to the Agency under FIFRA to reduce the risks from the registered uses of a pesticide.

1. Classification for Restricted Use

FIFRA Section 3(d) enables the Agency to restrict a pesticides use(s) if such use(s) cause unreasonable adverse effects. This classification means that the pesticide may only be applied by or under the supervision of a certified applicator, one who is trained and approved by a state as competent to use restricted pesticides.

2. Amend the Terms and Conditions of Registration Including Changes in Labeling

One of the requirements for registration as specified in FIFRA section 3(c)(5) is that labeling of a pesticide product comply with the requirements of FIFRA. That is, the product when used in accordance with directions for use will not result in unreasonable adverse effects to man or his environment. The Agency may require a registrant to amend the registration by revising labeling or otherwise modifying the conditions of use in order to keep the product in compliance with FIFRA. Examples of labeling changes include removal of certain uses from those registered, requiring protective clothing, respirators, hazard warning to applicators, changes in application rates or methods, and other use or handling directions which are designed to reduce risks to man or his environment.

3. Summary

In summary, FIFRA and the FFDCA provides the Agency with several legal authorities for a number of regulatory options for special review pesticides. Given this legal authority, the Agency next must explore possible use restrictions (i.e., amendments to the terms and conditions of registration), and evaluate the extent to which these restrictions would reduce the risks of dicofol.

E. REGULATORY OPTIONS FOR DICOFOL

Three basic regulatory options have been developed:

Option 1 -- Allow the registrants to continue to manufacture and market their current dicofol products with no further reduction in the amount of DDTr contamination levels. This option would mean that the Agency has found that the risks of the current levels of DDTr in dicofol would be acceptable in light of the benefits.

Option 2 -- Amending the terms and conditions of registration, to require registrants to reduce DDTr contamination in the manufacturing-use products to a level below that of the current products. Two registrants have proposed lowering the DDTr levels in their manufacturing-use products. This option would mean that the Agency would have to find the risks from the lowered DDTr levels acceptable in light of the benefits.

Option 3 -- Cancel registrations of dicofol. This option would mean that the sale or distribution of the pesticide would be prohibited. This option would be based on a determination that the risks from dicofol with either current levels or reduced levels of DDTr would be unreasonable in light of the benefits.

A fourth option, to place various restrictions on the use of dicofol products, was examined but rejected. These various restrictions and the reason why the Agency discounted them are discussed below:

1. Reduce the application rate or frequency of application.

The Agency agrees that a sufficiently reduced application rate or frequency could reduce the potential effects, but they would have to be extremely low. One registrant noted that a restriction such as this would leave the product ineffective.

2. Restrict application of dicofol products geographically, either away from areas where DDT background levels are already high, or away from areas where sensitive birds nest.

This alternative does not appear to be viable. Since the adverse effects to wildlife can occur solely from a single application of dicofol, use directions relating to the background level cannot avoid the unreasonable adverse effects on the environment. The Agency believes that there is no agriculturally important area where the product could be applied that would not result in exposure to sensitive birds.

3. Restrict application to a time of year when birds are not reproducing.

This alternative would not be effective since the DDTr ingested at any time of year is bioaccumulated in the fat of the birds, and since DDTr persists in the environment long after application.

The Agency also considered a fifth option -- a phase-out for dicofol products, rather than an immediate cancellation. This was also rejected because the adverse effects to wildlife would still be occurring during that time period and the continued addition of DDTr to the environment would continue to slow the rate of decline. The benefits of dicofol remain the same, i.e., alternatives are currently available for most uses of dicofol, and the nationwide impact of cancellation is expected to be minimal. Thus, the Agency has concluded that the use of dicofol during any phase-out period would result in unreasonable adverse effects.

F. RISK/BENEFIT ANALYSIS OF REGULATORY OPTIONS, USE BY USE

1. Cotton

a. Option 1

If registrations of dicofol products for use on cotton were continued without restriction, an estimated 72,000 pounds of DDTr would be released into the environment, mostly concentrated in the San Joaquin Valley in California. As detailed in Chapter II, this release of DDTr would likely cause adverse effects on wildlife, both in California and neighboring states.

Under Option 1 the economic benefits would continue unaffected. These benefits are estimated to be between $10.2 and $30.1 million over the short term and between $11.9 and $41.2 million over the long term to cotton producers in the San Joaquin Valley. The nonmonetary benefits would also continue, i.e., the usefulness of dicofol in integrated pest management programs and having dicofol available to slow development of pest resistence to alternatives. The minimal benefits to the consumer would also continue.

The Agency has compared the risks to wildlife and the benefits of dicofol use and has concluded that continuing the registration of dicofol on cotton will present an unreasonable adverse effect to the environment. Therefore, this option is rejected.

b. Option 2

If the level of DDTr in dicofol products were lowered below the current certified levels, there would still be exposure and adverse effects to wildlife to DDTr. Even though the registrants have proposed to lower DDTr to almost half of the current levels, the Agency believes that this level would still cause adverse effects. In addition, because the Agency has no data showing a level of DDTr exposure below which adverse effects on wildlife will not occur, it has no basis for specifying a level of DDTr in dicofol that would result in environmental residues that would be free of adverse effects.

Under Option 2 the economic benefits would also continue unaffected. These benefits are estimated to be between $10.2 and $30.1 million over the short term and between $11.9 and $41.2 million over the long term to cotton producers in the San Joaquin Valley. The nonmonetary benefits would also continue, i.e., the usefulness of dicofol in integrated pest management programs and having dicofol available to slow development of pest resistence to alternatives. The minimal benefits to the consumer would also continue.

Based on a weighing of the continued risks of a lowered amount of DDTr to wildlife against the benefits of dicofol, the Agency concludes that these risks outweigh the benefits and that this option is unacceptable.

The Agency may give further consideration to this option if the registrants were to substantially reduce the DDTr levels further and provide new evidence demonstrating that this reduced DDTr level would not pose an unreasonable adverse effect to wildlife.

c. Option 3

If the registrations of dicofol products for use on cotton were cancelled, all DDTr-related risks, from the use of dicofol, to the environment would be eliminated.

Benefits from the use of dicofol for cotton production would be lost. Current cotton producers in the Southeast could switch to alternative miticides at no increased costs, while those in Arizona and California (outside of the San Joaquin Valley) may switch to alternatives, but would incur an added insubstantial increase in treatment costs. The cotton producers in the San Joaquin Valley would be most affected by cancellation. In the short term, losses ranging from $10.2 and $30.1 million, and in the long-term, losses to these producers could range from $11.9 - $41.2 million, depending upon the yield reduction experienced. It is possible that some of the San Joaquin Valley producers might be forced to switch to alternative crops. Even if a substantial shift out of cotton occurred in the San Joaquin Valley, the current national acreage would continue at a level which would permit growers in other areas to fill the supply gap. In addition, the prices faced by consumers of cotton products most likely would rise only slightly, or not at all.

Significant nonmonetary benefits of dicofol could also be lost. The most important ones are: 1) Dicofol is only effective against mites, unlike many of the possible broad spectrum insecticide/miticides, and this makes dicofol the choice of many integrated pest management programs, 2) Tolerance or resistance of mites to alternatives and dicofol is a critical factor in selecting and alternating these pesticides, and 3) Reduction in the number and type of miticides will increase usage of the remaining miticides, increase selective pressure, and accelerate development of resistance to the remaining pesticides.

After weighing these benefits against the substantial risks to the environment, the Agency has concluded that the continued use of DDTr contaminated dicofol would cause unreasonable adverse effects to the environment and that registrations of dicofol products intended for use on cotton should be cancelled.

2. Citrus

a. Option 1

If registrations of dicofol products for use on citrus were continued without restriction, an estimated 100,000 pounds of DDTr would be released into the environment, principally in the citrus growing regions of Florida, southern Texas, Arizona, and California. This resulting exposure to the environment would likely cause adverse effects to wildlife in these local growing areas, as well as potential effects to wildlife throughout the country due to the uncontrollable mobility of DDTr.

Under Option 1 the economic benefits would continue unaffected. These benefits are estimated to range from between $3.5 and $4.0 million annually, which is less than 0.02 percent of the total U.S. production. The nonmonetary benefits would be similar to that of cotton.

The Agency has compared the risks to wildlife and the benefits of dicofol use and has concluded that continuing the registration of dicofol on citrus will present an unreasonable adverse effect to the environment. Therefore, this option is rejected.

b. Option 2

If the level of DDTr in dicofol products were lowered below the current certified levels, there would still be levels of exposure resulting in adverse effects to wildlife. Even though the registrants have proposed to lower DDTr to almost half of the current levels, the Agency believes that this level would still cause adverse effects. In addition, the Agency has no data showing a level of DDTr exposure below which adverse effects on wildlife will occur. The Agency has no basis for for specifying a level of DDTr in dicofol that would result in environmental residues that would be free of adverse effects.

The benefits consideration would be the same as described under Option 1. Based on a weighing of the continued risks of a lowered amount of DDTr to wildlife against the benefits of dicofol, the Agency concludes that these risks outweigh the benefits and that this option is unacceptable.

The Agency may give further consideration to this option if the registrants were to substantially reduce the DDTr levels further and provide new evidence demonstrating that this reduced DDTr level would not pose an unreasonable adverse effect to wildlife.

c. Option 3

If the registrations of dicofol products for use on citrus were cancelled, all DDTr-related risks from further use of dicofol to the environment would be eliminated.

The economic impact associated with the cancellation of dicofol use on citrus crops is expected to range from \$3.5 to \$4.0 million annually. These increased costs are due to the higher cost of using alternatives. There is no anticipated reduction in yields. The average value of U.S. citrus production between 1977 and the present has been approximately \$1.8 billion based on the equivalent packinghouse-door fresh and processed sales. The aggregate dollar impact of dicofol cancellation (\$3.5 - \$4.0 million) is expected to be less than 0.02 percent of the value of total U.S. production. The nonmonetary benefits would be similar as those for the cotton use.

After evaluating the environmental risks and the economic benefits associated with dicofol use in the citrus industry, especially in the citrus growing areas of Florida, Texas, Arizona, and California, the Agency has determined that the continued use of DDTr contaminated dicofol on citrus would cause unreasonable adverse effects to the environment and concludes that registrations of dicofol products intended for use on citrus should be cancelled.

3. Other Uses

Dicofol is used to control many species of mites on other minor sites, i.e., seed crops, pome and stone fruits, ornamental plants, turf grasses, vegetables, tree nuts, small fruits, mint, and home and garden uses. About a third of dicofol produced is applied to these sites.

a. Option 1

The Agency does not have specific risk data on these sites. However, based on the known effects of and mobility of DDTr in the environment, it is reasonable to assume that the same adverse effects that could appear in the citrus and cotton growing areas would likely occur in these use sites.

Under Option 1 the economic benefits would continue unaffected. The benefits of dicofol use on all minor use sites has not been quantified to date. However, for a few sites, it is estimated that these benefits are between \$1.1 and \$1.4 million for producers of apples, nuts, and mint.

The nonmonetary benefits would also continue, as well as the benefits to the consumer.

The Agency has compared the potential risks to wildlife and benefits of dicofol use and concluded that continuing the registration of dicofol for use on these minor sites will present an adverse effect on the environment. Therefore, this option is rejected.

b. Option 2

If the level of DDTr in dicofol products were lowered below the current certified levels, there would still be an exposure resulting in adverse effects to wildlife. Even though the registrants have proposed to lower DDTr to almost half of the current levels, the Agency believes that this level would still cause adverse effects. In addition, because the Agency has no data showing a level of DDTr exposure below which adverse effects on wildlife will not occur, it has no basis for specifying a level of DDTr in dicofol that would result in environmental residues that would be free of adverse effects.

The benefits consideration would be the same as described under Option 1. Based on a weighing of the continued risks of a lowered amount of DDTr to wildlife against the benefits of dicofol, the Agency concludes that these risks outweigh the benefits and that this option is unacceptable.

The Agency may give further consideration to this option if the registrants were to substantially reduce the DDTr levels further and provide new evidence demonstrating that this reduced DDTr level would not pose an unreasonable adverse effect to wildlife.

c. Option 3

If the registrations of dicofol products for use on these other sites were cancelled, all DDTr-related risks from further use of dicofol to the environment would be eliminated.

The economic impacts relating to the cancellation of dicofol use on all minor use sites has not been quantified to date. However, it is estimated that production costs will increase from $1.1 to $1.4 million for producers of apples, nuts (principally pecans) and mint, solely as a result of using costlier alternatives. The remaining minor use sites are likely to realize some level of negative impacts, the magnitude of which is unknown. The nonmonetary benefits to these other uses that would be lost would be similar to that of cotton and citrus.

After evaluating the environmental risks and the economic benefits associated with dicofol use in these other sites, the Agency has determined that the continued use of DDTr contaminated dicofol on these other sites would cause unreasonable adverse effects to the environment and concludes that registrations of dicofol products intended for use on these other sites should be cancelled.

The Agency will consider rebuttal comments on the benefits of dicofol use on each individual site in its final decision and will consider retaining uses for which benefits are high and the risks are low.

G. SUMMARY OF PROPOSED REGULATORY DECISION

1. Cotton Use

Cancel all registrations for dicofol use on cotton.

2. Citrus Use

Cancel all registrations for dicofol use on citrus.

3. Minor Uses

Cancel registrations for all minor uses of dicofol.

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